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Pesticide Exposure to Florida Greenhouse Applicators

Agricultural Research and Education Center
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The exposure of pesticide applicators in a commercial greenhouse facility was assessed. Data were collected primarily from five handgunners and a tractor driver. The chemicals applied were fluvalinate, chlorpyrifos, ethazol, dicofol, captan, and chlorothalonil. Potential exposure was assessed with exposure pads placed outside all clothing of the applicator. Handwashes and air samples were also collected, as were pre- and post-exposure tank mixture samples. Pesticide penetration was measured with exposure pads placed inside protective clothing.

Handgunner exposure increased with increasing fineness of the spray leaving the nozzle; the tractor driver was much less exposed than the handgunners. Ethazol penetrated Tyvek™ more than any other compound tested. It was found useful in this study to normalize all exposure assessments for spray rate.

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PESTICIDE EXPOSURE TO FLORIDA GREENHOUSE APPLICATORS

by

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FOREWORD

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water system. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. The Clean Water Act, the Safe Drinking Water Act, the Federal Insecticide, Fungicide, and Rodenticide Act, and the Toxic Substances Control Act are four of the major congressional laws that provide the framework for restoring and maintaining the integrity of our Nation's water, for preserving and enhancing the water we drink, and for protecting the environment from toxic substances. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Water Engineering Research Laboratory is that component of EPA's Research and Development program concerned with preventing, treating, and managing municipal and industrial wastewater discharges; establishing practices to control and remove contaminants from drinking water and to prevent its deterioration during storage and distribution; and assessing the nature and controllability of releases of toxic substances to the air, water, and land from manufacturing processes and subsequent product uses. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

The exposure of greenhouse applicators is a current regulatory interest of the U.S. Environmental Protection Agency. The U.S. EPA is specifically faced with the task of (1) assessing the potential pesticide exposure of greenhouse applicators and (2) for pesticide label requirements, suggesting protective clothing which is both effective and comfortable. This study is a first step toward providing the data necessary for these evaluations. The primary "data user" is, therefore, the U.S. Environmental Protection Agency. Secondarily, the data is of use to the greenhouse industry and to pesticide manufacturers.

Francis T. Mayo, Director
Water Engineering Research Laboratory

ABSTRACT

The exposure of pesticide applicators in a commercial greenhouse facility was assessed. Data were collected primarily from five handgunners and a tractor driver. The chemicals applied were fluvalinate, chlorpyrifos, ethazol, dicofol, captan, and chlorothalonil. Potential exposure was assessed with exposure pads placed outside all clothing of the applicator. Handwashes and air samples were also collected, as were pre- and post-exposure tank mixture samples. Pesticide penetration was measured with exposure pads placed inside protective clothing.

Handgunner exposure increased with increasing fineness of the spray leaving the nozzle; the tractor driver was much less exposed than the handgunners. Ethazol penetrated Tyvek™ more than any other compound tested. It was found useful in this study to normalize all exposure assessments for spray rate.

This report was submitted in fulfillment of cooperative agreement CR-810743 by the Florida Pesticide Hazard Assessment Project, University of Florida, under the sponsorship of the U.S. Environmental Protection Agency. This report covers a period May 1, 1985 to April 30, 1986 and work was completed as of December 31, 1986.

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ABBREVIATIONS

Abbreviation	Explanation
a.i.	active ingredient
EC	emulsifiable concentrate
ETBAR	estimated total body accumulation rate: as estimated from outside pads
GLC	gas-liquid chromatograph(y)
ppb	parts per billion
ppm	parts per million
S.E.M.	standard error of the mean: the standard deviation divided by the square root of the number of replications
WP	wettable powder

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We wish to thank the subjects who participated in this study and the owners and operators of the greenhouse facility where the study was conducted. Without their cooperation, no investigation of this size and scope would have been possible.

SECTION 1

INTRODUCTION

A small study of applicator exposure has appeared in the literature (Mestres et al. 1985). Only two applicators were studied in this experiment: one sprayed dicofol onto potted lemon trees in a plastic greenhouse with a "pneumatic disc-harrow" apparatus; the other applied deltamethrin onto beans with a vaporizer (probably a pulse fogger). The applicators wore work clothing with gloves and a 'mask'. Air samples were taken and collection devices were placed under the clothing. The dermal dicofol exposure, including hands, was estimated at 0.57 mg/hr and the deltamethrin exposure at 3.36 mg/hr. A reentry interval was calculated from sequential air samples. This study was very preliminary and essentially valueless. A second study by Waldron (1985) reported air concentrations and residues on glass slides. Dichlorvos and permethrin showed rapid air concentration decreases, especially when vents were opened to the outside. The author speculated that climatic-atmospheric conditions affected the persistence of residues, but only solar data were presented to confirm this and the residue data were difficult to assess. The author alluded to data on applicator exposure levels, but these were not reported.

The study described here was conducted in 1985-86 at a commercial greenhouse facility in west-central Florida. The facility, devoted primarily to growing chrysanthemums and African violets, occupied three locations: at Parrish, FL and Palma Sola, FL where handgunners were monitored, and at Cortez, FL where a tractor driver was monitored.

Data were collected from five handgunners who sprayed either a fine spray, a coarse spray, or with a pulse fogging device; the tractor driver who pulled either a boom sprayer or a span sprayer; a drencher; and an assistant to a fine spray handgunner. The chemicals applied were fluvalinate, chlorpyrifos, ethazol, dicofol, captan, and chlorothalonil (TABLE 1).

The questions this study addressed were the following: (1) What is the potential for dermal exposure to greenhouse pesticide applicators? In other words, at what rate would pesticide accumulate on the body of an applicator, unprotected by clothing of any kind? We term this "estimated total body accumulation rate" (ETBAR) and measure it in µg/h. Also, does the ETBAR depend upon the rate of pesticide leaving the spray nozzle, the kind of pesticide applied, the method of application (including type of nozzle), and/or the individual work habits of the applicator? (2) How is the ETBAR distributed over the anatomy of the applicator and upon what parameters does this distribution depend? (3) What is the accumulation rate of pesticide on the hands of applicators? Is there a relationship between worker hand preference (right or left) and exposure to the right and

left hands? Does hand exposure depend upon the pesticide effluent rate, compound applied, application method, and/or individual work habits? (4) What is the atmospheric contamination of the pesticide in the breathing zone of the worker as he applies the compound? Does it depend upon the compound, its effluent rate, or the application method? (5) What is the penetration of pesticide through the various types of protective clothing worn by applicators? Does penetration depend upon the compound? (6) How do samples of the spray mixture, taken pre- and post-application, compare in pesticide concentration with that presumed to exist in the tank based on the mixture recipe and an assumption of thorough mixing?

SECTION 2

CONCLUSIONS

The ETBAR was found to depend upon the presumed pesticide spray rate, somewhat on the compound sprayed, but primarily on the method of application. Handgunners were at highest potential risk, with ETBAR values reaching 100 mg/h; the tractor driver was at considerably less risk, particularly when using a span sprayer (0.7 mg/h). The distribution of the ETBAR over the workers' bodies depended only on the application method used. Except for the tractor driver, pesticide was primarily deposited on the legs.

No statistically significant difference was found in handwash pesticide between the right and left hands of workers. Pesticide on hands did depend on spray rate, very little on chemical type, and principally on the method of application. Handgunners accumulated the most, with the tractor driver receiving significantly less.

The atmospheric pesticide contamination, as measured by personal air samplers, depended upon the pesticide spray rate, the work practice, and the compound. Highest values were found for fine spray handgunners (particularly when applying fluvalinate) and pulse foggers; moderate levels occurred for the tractor driver (particularly when he applied chlorpyrifos with a boom sprayer) and the coarse spray handgunner. Generally, the finer the spray emanating from the nozzles, the more the breathing zone was contaminated. Ethazol contaminated the atmosphere the most, followed distantly by chlorpyrifos.

Pesticide penetrated through Tyvek™ coveralls with a transmittance (% penetration) of 0-23%, depending strongly upon the potential amount of pesticide to be transmitted and the compound itself. Penetration of the compounds through the coverall at the forearm location was significantly greater for ethazol than for fluvalinate. Also, significantly more ethazol than fluvalinate or chlorpyrifos penetrated the coverall/apron barrier at the chest and thigh.

Differences in individual work habits of those workers applying the same pesticide by the same method resulted in little variation in the ETBAR, its distribution, air samples, or handwashes. This became apparent only when these measurements were normalized for spray rate.

Statistical analyses of the pre- and post-application tank mixtures showed no significant difference between the two. But, particularly for chlorpyrifos, ethazol, and captan (all wettable powder formulations), less than 50% of the pesticide concentration presumed to exist in the tank on the

basis of the mixture recipe was actually found. Fluvalinate and dicofol (both emulsifiable concentrates) were significantly closer to expectations. Chlorothalonil, a wettable powder, was an exception to the above dichotomy, with no discrepancy from expectations.

SECTION 3

RECOMMENDATIONS

For reasons not clearly understood, Tyvek™ coveralls were observed to have much less penetration resistance against ethazol than against the other pesticide formulations. It is therefore recommended that the cause of this phenomenon be evaluated further in order to learn how to minimize such penetration and be able to identify other garment material-pesticide formulations that might also exhibit higher than normal penetration levels.

Suits should be constructed with oversized long sleeves and a closure device at the wrist; hoods should be part of the suit. Applicators should wear rubber gloves extending to mid forearm, rubber boots, and respirators. Where necessary, pesticide mixing methods in the tank should be updated, particularly for wettable powder formulations. This way, better pest control could result and/or less pesticide could be used.

We further recommend that four additional coverall fabrics be field-tested for penetration in a commercial greenhouse setting. The materials we suggest are Duragard™, SMS, treated twill, and untreated twill. These materials will have undergone a prior battery of laboratory tests for penetration at the Department of Textiles, Merchandising and Design (Dr. J. O. DeJonge), University of Tennessee, Knoxville, TN 37996. Handgunners, who constitute the applicator group at greatest potential risk, should be employed as subjects. The compounds monitored should be fluvalinate, chlorpyrifos (the two most frequently applied compounds at our cooperating facility), and ethazol (of those tested, the most penetrating compound through Tyvek™). Field-testing these fabrics for thermal comfort could best be undertaken in a separate study.

SECTION 4

MATERIALS AND METHODS

EXPERIMENTAL SUBJECTS

Seven subjects were chosen for this study on the basis of their willingness to participate and the frequency with which they applied compounds which our laboratory was capable of analyzing. They were instructed to change no aspect of their normal application routine and to wear only their usual protective clothing. Four subjects were male, three were female, and they ranged in age from 23 to 44 years (TABLE 2). Their heights and weights were recorded, and from these their total body surface areas estimated by the formula of Gehan and George (1970). The hand preference of each was recorded.

APPLICATION METHODS AND SITES

Four of the workers normally sprayed with a Cornell handgun equipped with a 6-nozzle head and attached with a long hose to a Myers Du-All Spray Pump™ and an open 60 gal cylindrical tank (TABLE 3). The spray mixture, sometimes containing several pesticide, fungicide, fertilizing, etc. compounds, was discharged from the nozzles as a fine, nearly misty, spray. These workers usually sprayed in completely enclosed greenhouses. Exceptions to these practices are footnoted in TABLE 3.

One worker sprayed from an enclosed 300 gal tank with a handgun, equipped with a single adjustable nozzle set to provide a coarser spray. He usually applied in an open-sided structure with a translucent roof. Exceptions are noted by footnote in TABLE 3.

The sixth subject drove a tractor which usually pulled a boom sprayer with an enclosed 300 gal tank. He applied in an open-sided structure covered on top with Siran™, a fine net-like fabric used to attenuate sunlight intensity in an otherwise completely open environment.

One exposure was taken from the seventh subject as she drenched. Drenching was done with a nozzle which gave a low pressure, coarse spray pattern not unlike what an ordinary sprinkling can would provide. It was done in an entirely enclosed greenhouse.

Pulse fogging was occasionally practiced by the fine spray handgunners in their enclosed greenhouses. The pulse fogging device (Dramm International Inc. Pulsfog™, Style K-6005) had an enclosed 8 gal tank and produced a misty (droplet size advertized at 0.03 mm) spray from a single nozzle.

Applicators mixed and loaded their own tanks.

PROTECTIVE CLOTHING

Protective clothing normally worn by each subject appears in TABLE 4, with exceptions footnoted. Coveralls were made from Dupont Tyvek™ (Abanda Coverall, Style 1412) as were the hoods (Abanda Hood, Style 2903). Coveralls and hoods covered all of the body surface except the face, hands, and feet. Both coveralls and hoods were disposable and changed between applications.

Gloves, extending to mid-forearm; boots, extending to mid-calf; and bibbed aprons, extending from mid-chest (or waist, if the bib was not raised) to the ankle, were all made of butyl rubber. Ends of the gloves were not sealed.

Goggles (Bouton, Style Z87) covered the eyes; respirators (Northern MSSN, Style 770-30 or Willson, Style R683) covered the nose and mouth. During pulse fogging, the respirator was replaced by a canister chin-style gas mask (Willson, Style 61F).

SAMPLING AND PRELIMINARY COMPUTATIONS

For each separate application, certain data were recorded: subjects' names; samplers' names, application site; compounds, formulation, and amount in the tank; amount of water in the tank; date and time of day the monitored application commenced and ended; amount of mixture sprayed; application method; protective clothing worn; temperature and humidity pre- and post-monitored application; beginning and ending times of exposed pad collection from the subject; transportation time and temperature from the experimental site to the storage location; storage location and storage temperature; samples collected, by type; sample condition; and comments by subjects or samplers. Many of these data appear in Appendix A, arranged by subject and compound.

Potential dermal and respiratory exposure was estimated according to the procedure described by Durham and Wolfe (1962). Exposure pads placed on the subjects were 10.16 cm x 10.16 cm (4 x 4 inch) and made of alpha-cellulose with a glassine weighing paper backing. Following application, samplers removed the subjects' outside pads which had been placed as follows: one on the middle of the back, slightly higher than shoulder blade level; one on the chest just below the collar bone; one on top of each shoulder; one on each forearm, slightly below the elbow and facing outward; one on the front of each thigh, midway between hip and knee and facing frontward; one on each shin, slightly below the knee and facing frontward. These pads were entirely exposed, not covered by protective gear of any kind. If an apron or boot covered any of the above sites, pads were placed on the outside of the apron or boot at the same level as described above. Left and right pairs of outside pads (shoulders, forearms, thighs, and shins) were combined for extraction and analysis. Time exposure periods were at the convenience of the subject but generally lasted about 30 min. After collection from the subject, each left and right pair of pads was wrapped in aluminum foil with exposed surfaces facing each other; back

and chest pads were wrapped singly. Pads were then placed on ice in a cooler for transportation to the laboratory. During pad removal, samplers handled the pads by their outside perimeters only. The analytical results for pesticide compound, uncorrected for recovery, divided by the pad area (one or two pads) and exposure time, give the pad fluxes appearing in Appendix A. The ETBAR was calculated from the outside pad fluxes as follows. Estimated fractional body surface areas were allotted to the head and neck, front torso, back torso, arms, upper legs, and lower legs using the proportions proposed by U.S. Environmental Protection Agency (1985) which are sex-specific. Accumulation rates to the arms, for example, are the product of the estimated total body surface area (TABLE 2), the arms fraction (14.1% male, 14.0% female), and the outside forearm pad flux (Appendix A). In the same way, upper leg accumulation rates were estimated from thigh pad fluxes, lower leg rates from outside shin pad fluxes, back torso rates from outside back pad fluxes, and front torso rates from outside chest pad fluxes. The head-neck accumulation rate was similarly derived, with the flux estimated from the average of the outside chest, the outside back, and twice the outside shoulder fluxes. These various accumulation rates were then summed to obtain the ETBAR. If any of these individual accumulation rates could not be estimated because of a lost or missing sample, no ETBAR was calculated. Handwash accumulation rates were included only if the subject wore no hand protection. The hands' contribution can then be regarded as truly exterior and, therefore, on the same footing as outside pads; otherwise, handwashes are omitted from the ETBAR. As a practical matter, ETBAR's were here not much influenced by the inclusion or exclusion of handwashes. Individual left and right handwash accumulation rates and ETBAR's appear in Appendix A, together with the ETBAR distribution, by percent. Handwashes were taken by placing the subject's hand in a Baggie™ containing 200 ml of 95% ethanol and shaking for 30 seconds. The Baggies™ were then tied and placed in pint Mason™ jars for transportation on ice to the laboratory. Also appearing in Appendix A are spray rates, the quotient of the amount of compound sprayed (calculated from the volume of mixture sprayed and the presumed concentration of compound in the mixture) and the monitored application time. The atmospheric pesticide contamination is given and is based upon a 3 L/min intake of air by the personal air sampler (Dupont P-4000). Human respiratory intake is about 14 L/min. Air samplers were calibrated for this 3 L/min rate every three days of use. The air sampler intake was through a cylindrical polyurethane foam filter plug whose housing was placed in a downward position and clamped securely to the subject's clothing immediately below the left shoulder. A plastic tube ran from the filter housing to the air sampler pump worn on the back of the waist and supported by a belt. This air sampling device is designed to collect primarily vapor and does not discriminate among particle sizes. Following the exposure period, the filter was removed with clean tweezers, wrapped in aluminum foil, and placed in the cooler on ice, pending transportation to the laboratory. Tank mixture samples were taken pre- and post-application: directly from the tank for the tractor driver and the coarse spray handgunner, and from the handgun itself for the other applicators.

Inside pads were used only for those subjects who wore protective gear. Inside pads were placed immediately inside the coverall just beneath, but not overlapping, the outside pad at the following positions: chest, both

forearms, both thighs, and both shins. Inside pads were not removed until all outside pads had been removed, the sampler had washed his own hands, and the sampler had "handled" a blank pad (the so-called "handled pad" of Appendix A) by the edges for quality control. While outside pads were without exception always exterior, inside pads were occasionally protected by more than the coverall: either by a rubber apron at the chest and thighs or by rubber boots at the shins. If no coverall was worn, inside pads were protected only by the apron or boots. Left and right pairs of inside pads (forearms, thighs, and shins) were combined for extraction and analysis.

Upon reaching the laboratory, all samples were stored in a freezer at -20°C.

EXTRACTION

Prior to exposure in the field, the alpha-cellulose pads were pre-extracted. Pads were tumbled in a jar containing methylene chloride (10 pads/1.5 L) for 10 minutes, air dried, and tumbled again in hexane. A glassine paper was attached to the pad, then 10 pads were wrapped in foil, and stored. The pre-extrated pads showed no interfering peaks by GLC analysis.

An identical extraction procedure for exposed pads was used for fluvalinate, chlorpyrifos, ethazol, captan, and chlorothalonil. Pads were center cut into a 2.5 x 2.5 inch (40.32 cm^2) square and quartered on a cutting board. The blade and cutting edge were washed with acetone and methanol after each pad was excised. The pieces were placed in an 8 oz jar with 50 mL hexane. The jars were shaken on a flat rack shaker (New Brunswick Scientific, Model R-2) for 5 minutes at 350 rpm. This process was repeated once. Extracts from the two steps were combined and placed on a rotary evaporator (Brinkman Instruments, Model RE-120) at 40°C. This sample was taken to dryness and transferred to 10 mL hexane. Samples were stored in 20 mL scintillation vials, sealed with opaque tape around the cap, and stored at -20°C until the sample was analyzed by gas chromatography. Dicofol pad extraction differed from the above procedure in that a 30% acetone - 70% hexane mixture was used to extract dicofol from the pads and 2,2,4-trimethylpentane was used to bring the sample up to 10 mL after drying down on the rotary evaporator.

The air sampler plugs were pre-extracted in a methylene chloride wash (8 plugs/2L), air dried, then washed in hexane. The plug was squeezed of all solvent, air dried, and packaged, 8 plugs per Ziploc™ storage bag. The pre-extracted plugs showed no interfering peaks by GLC analyses.

An identical extraction procedure for exposed plugs was used for fluvalinate, chlorpyrifos, ethazol, captan, and chlorothalonil. Plugs were placed in an 8 oz jar with 50 mL of hexane and shaken on the flat rack shaker for 5 minutes at 350 rpm. This process was repeated once. Extracts from the two steps were combined, placed on the rotary evaporator at 40°C until dry, and transferred to 10 mL of hexane. Samples were stored in 20 mL scintillation vials, sealed around the caps with opaque tape, and stored at -20°C until GLC analysis. Dicofol plug extraction differed in that a 30% acetone - 70% hexane mixture was used to extract dicofol from the plugs, and

2,2,4-trimethylpentane was used when bringing the sample up from dryness to 10 mL.

Handwash sample extractions were identical for fluvalinate, chlorpyrifos, ethazol, captan, and chlorothalonil. The sample contained in the Baggie™ was poured into a 500 mL separatory funnel along with 100 mL of de-ionized water and 50 mL of hexane. This mixture was gently shaken for 30 seconds and left standing until the phases separated. The hexane layer was collected. This procedure was repeated once. The extracts were combined, placed on the rotary evaporator at 40°C until dry, and transferred to 10 mL of hexane. Samples were stored in 20 mL scintillation vials at -20°C. Dicofol handwash extraction differed in that 2,2,4-trimethylpentane was used to bring the samples from dryness to the final 10 mL volume.

Tank mixture samples were warmed to room temperature and mixed thoroughly in the sample bottle. One mL of sample was removed, weighed in a pre-tared 50 mL volumetric flask, and brought to volume with acetone. The sample was then transferred to an amber bottle and stored at -20°C for later GLC analysis.

GAS CHROMATOGRAPHIC ANALYSIS

All analyses were done by gas chromatography using electron capture Ni^{63} detection. Operating conditions for analyses of the various compounds appear in TABLE 5a-e. The lower quantitative limit of the GLC was defined as 10 times the baseline noise level for the instrument. Minimum detection limits and their equivalents in exposed substrate units are given in TABLE 6 for all compounds. A standard curve, consisting of at least four different known standard concentrations, was run jointly with samples of unknown concentrations. During an analytical run, standards were introduced no less often than every five exposed samples. After GLC analysis, samples were stored in freezers at -20°C until discarded.

For quantitative purposes, fluvalinate (Lot No. AR0884099, 96.2% purity) was obtained from Zoecon Corporation, Palo Alto, CA 94303. Chlorpyrifos (Lot No. T303, 99.9% purity), ethazol (Lot No. C02P, 100%), p,p'-dicofol (Lot No. D791, 100%), and chlorothalonil (Lot No. T100, 99.9%), were obtained from the United States Environmental Protection Agency, Pesticide and Industrial Chemicals Repository, Research Triangle Park, NC 27711. Captan (Lot No. 5722-43, 99.0% purity) was obtained from Chevron Chemical Corp., San Francisco, CA 94105.

SECTION 5

RESULTS AND DISCUSSION

The grouping of the data in Appendix A and the TABLES is arbitrary. In actuality, each exposure was an experiment unto itself--variations existed in compounds, compound spray rates, exposure times, application methods, subjects, etc. No exposure constituted a true replication of any other exposure because of these confounding variables which were not under our experimental control. Any grouping of data, therefore, is somewhat artificial. Yet, in order to draw any general conclusions, some grouping of data into classes is required. With apologies to statistical purists, this task was undertaken. Happily, in practice, there was little variation in presumed effluent rate (kilograms active ingredient per hour) from applicators' spray nozzles when a given subject applied a given compound by a given method. This suggested grouping all such individual exposures (Appendix A) together into subgroups, each subgroup corresponding to a given subject/compound/ application method (TABLE 7a-g) for which the spray rate varied little from application to application.

At this point, we digress for a moment. The phrase "presumed effluent rate" suggests some ambiguity and derives from our observation that thorough mixing of compound was not usually accomplished in the spray tank. TABLE 8 gives the pre- and post-spray tank mixture analyses for concentration, expressed as percents of the presumed concentration. While no statistical difference existed between the pre- and post-spray samples, the data showed that for chlorpyrifos, ethazol, and captan (all formulated as wettable powders), less than half of the compound presumed to be leaving the spray nozzle, actually was. This circumstance was less pronounced for fluvalinate and dicofol (both formulated as emulsifiable concentrates) and entirely absent with chlorothalonil, a wettable powder which unaccountably appeared to be well-mixed. It is, of course, possible that losses of compound from the tank mixture samples occurred during storage prior to their being analyzed and that the discrepancy we appear to have detected between the tank mixture recipe and the tank mixture itself is spurious. With this digression as a caveat, we return to our grouping scheme, whereby all exposures of a given subject spraying a given compound by a given method are combined.

The ETBAR, handwash, and air sampler data were subgrouped in TABLE 7a-g and presented according to: first, application method; second, compound applied; and finally, subject. Mean $\pm$ S.E.M. values are reported, together with number of "replications" (separate applications). The standard error of the mean (S.E.M.) is the standard deviation divided by the square root of the number of replications. This reporting format is used, where applicable, throughout this report. From TABLE 7a-g, it is evident that

significant differences in mean ETBAR, handwashes, and air samples exist between subjects applying the same compound by the same method. These differences are not surprising, given the fact that mean spray rates also vary among subjects. There is a general tendency, by no means without exception, that when large differences in these exposure parameters occur, they are explainable on the basis of mean presumed spray rate differences (see, e.g., in TABLE 7a subject VG applying fluvalinate with a fine spray handgun as compared with other subjects of this class, or in TABLE 7c subject GG applying fluvalinate with a pulse fog handgun as compared with other subjects of this class). This effect was tested by obtaining correlation coefficients between mean spray rate and ETBAR, handwash, and air sample data (TABLE 7a-g) for each of the five work practices (drencher and assistant excluded). Of the 15 correlation coefficients, 13 were positive and averaged 0.629. Consequently, these exposure parameters of TABLE 7a-g were all normalized for (divided by) spray rate. What resulted was a measure of "mg-deposited per kg-sprayed", the time units having cancelled out. Air sample values had first to be translated to mg/h via the 3 L/min factor. These normalized mean values then did not differ significantly among subjects within a given compound/application- method class, and subjects were, therefore, combined in TABLE 9a-c. This non-significance among subjects was confirmed with an ANOVA (analysis of variance) at $p < 0.05$. Left and right mean handwash data (TABLE 7a-g) also showed no significant differences ($p < 0.5$) throughout and were summed to give "total mean handwash" prior to the ANOVA and their inclusion in TABLE 9a-c. A word of caution regarding these ANOVA results should be given. That no significant difference existed among subjects for the various normalized exposure parameters, as evidenced by the ANOVA, derives as much from the rather large variations within single-subject groups as it does from the small differences in mean values between such groups. In other words, had "replicates" varied less, the normalizing procedure may not have been justifiably used to "smooth out" the data within a compound/ application-method class.

The standard errors in TABLE 9a-c reflect not only the variation in exposure parameters among "replicates", but also the slight variation in presumed spray rate.

One could ask whether differences exist among compounds for the various normalized parameters and application methods given in TABLE 9a-c. To answer this, a Duncan's New Multiple Range Test ($p < 0.05$) was applied to each of the pesticide groups. The few significant differences which were found are presented in TABLE 10. The analysis summarized in TABLE 10 shows that fine spray and pulse fog handgunners were at significantly ($p < 0.05$) more risk to normalized ETBAR (NETBAR) contamination by fluvalinate than from the other compounds tested. The coarse spray handgunner and the span spray tractor driver, both of whom also sprayed fluvalinate, were significantly more at risk to NETBAR contamination from chlorothalonil and chlorpyrifos, respectively. Regarding normalized handwash contamination, the boom spray tractor driver was significantly more at risk from chlorpyrifos than from fluvalinate or captan. For normalized air sampler contamination, fine spray handgunners were significantly more at risk from ethazol than from fluvalinate, chlorpyrifos, or dicofol; the boom spray tractor driver was more at risk from chlorpyrifos than from fluvalinate or

chlorothalonil; the span spray tractor driver was more at risk from chlorpyrifos than from fluvalinate. We cannot explain these differences among compounds.

Comparing the various work practices, it can be observed from TABLE 9a-c that the NETBAR data form general classes. Largest NETBAR values came from handgunners of all types and the drencher, moderate values from the boom spray tractor driver and the assistant are an order of magnitude lower, and finally lowest values by another order of magnitude came from the span spray tractor driver. There is a further tendency within the handgunner group for fine spray handgunners to receive more NETBAR than coarse spray or pulse fog handgunners. These general trends are more or less pronounced depending upon the chemical applied. We should emphasize at this point that our separation of handgunners by fineness of spray is a qualitative separation based on visual observation only and unsupported by any measurements. For normalized handwash data, there are, once again, three obvious work practice classifications. Handgunners as a group received the most, followed by the tractor driver and the drencher with about an order of magnitude less hand contamination, and finally the assistant with a slight amount only. For normalized air sampler data, three classifications suggest themselves: highest values are found with fine spray handgunners and pulse foggers (the assistant assisted a fine spray handgunner), about one order of magnitude lower values came from the coarse spray handgunner and the tractor driver, and finally the drencher whose air sampler detected nothing. One possible explanation of this last result is that the finer the spray, the greater the atmospheric contamination, either because of the smaller droplet size or because of enhanced volatilization from surfaces. Another operating factor may be the type of greenhouse structure in which the application was carried out. Fine spray handgunners and pulse foggers applied pesticide in enclosed structures; the coarse spray handgunner applied in an open sided house; the tractor driver applied in an open setting, except for a net ceiling. Thus, fineness of spray is confounded here with openness of structure. The finer spray applications occurred in more enclosed structures. It may be that the enclosed environment rather than the finer spray is the critical factor for atmospheric contamination.

The distribution of the ETBAR to various body regions of the worker is given in TABLE 11a-g. As before, mean values have been taken over different exposures of the same subject applying the same compound by the same method. Normalization for spray rate was not done here, under the assumption that spray rate should not affect the percent of compound deposited on a given body area. Analyses of variance ($p < 0.05$) showed no statistical difference in the distribution of compound among either subjects or compounds. Hence, mean ETBAR distribution is grouped in TABLE 12 only according to application method. The distribution of spray, it is clear, does depend upon the application method. Generally, however, it is to be noted that, although the upper and lower legs together comprise only 38% of the body's surface area, this region accounted for 63-99% of the ETBAR. The exception to this was the tractor driver whose legs were above the spray nozzles and also were somewhat shielded by the tractor.

Penetration of pesticide through protective clothing was assessed by computing the ratio of inside pad flux to that of the corresponding outside pad. This value we call transmittance, a term borrowed from optics. We do

note, however, that inside pads can suffer contamination by other routes than directly through the protective clothing. For example, samplers observed in the field that when an applicator extended his arm, the sleeve of the coverall had a tendency to ride up, exposing the inside forearm pad. We intend here to include all such events in transmittance, with the latter term interpreted very loosely. Mean transmittance over all subjects and work practices is presented in TABLE 13. A mean transmittance of zero indicates that its mean value was less than 0.005. It is clear from TABLE 13 that transmittance depends both on compound and location on the subject. The data suggest that the transmittance may not, under field conditions, be a constant value for a given compound penetrating a given fabric. There is a tendency for transmittance to be smaller when outside pad contamination is larger, as is the case in this experiment with thigh and shin pads. Note, for example, the difference in mean transmittance values for chlorpyrifos penetrating only the coverall. Significant differences among compounds in TABLE 13 were assessed through a Duncan's New Multiple Range Test ($p < 0.05$). Standard errors were large, so that the only differences confirmed (TABLE 14) involve the greater penetrating ability of ethazol vis-a-vis fluvalinate and chlorpyrifos.

TABLE 13 is absent 18 transmittance values, often greater than one, which were deemed outliers. Transmittance outliers were identified with a statistical test: if any transmittance differed by 5 or more standard deviations from the mean transmittance appearing in TABLE 13 which excludes the transmittance in question, it was determined to be an outlier. This test will misidentify outliers only once in 10^6 times.

Transmittance outliers are listed in TABLE 15. Each outside and inside pad contamination, from which these outliers were derived, was reanalyzed on the gas chromatograph. No significant differences from the original values resulted. We attribute these unusual transmittances then to one of two causes. First, the fact that some of the outliers involved samples collected on the same date from the same subject suggests a labelling error (interchanging outside and inside) in the field or the laboratory. A second possibility is that there existed a direct route for the pesticide to contaminate the inside pad other than passing through the protective clothing.

REFERENCES

Durham, W. F., and H. R. Wolfe. Measurement of the exposure of workers to pesticides. Bull. Wld. Hlth. Org., 26:75-91, 1962.

Gehan, E. A., and S. L. George. Estimation of human body surface area from height and weight. Cancer Chemotherapy Reports, Pt. I, 54(4):225-235, Aug. 1970.

Mestres, R., C. Francois, C. Causse, L. Vian, and G. Winnett. Survey of exposure to pesticides in greenhouses. Bull. Environ. Contam. Toxicol., 35:750-756, 1985.

U.S. Environmental Protection Agency, Washington, D.C. Development of statistical distributions or ranges of standard factors used in exposure assessments. No. 600-8-85-010. Office of Research and Development, 1985.

Waldron, A. C. The potential for applicator-worker exposure to pesticides in greenhouse operations in Dermal Exposure Related to Pesticide Use. [eds. R. C. Honeycutt, G. Zweig and N. Ragsdale] ACS Symp. Ser. No. 273, pp. 311-319, ACS, Washington, D. C., 1985.

TABLE 1. COMPOUNDS AND FORMULATIONS

Common name	Chemical name	Brand name	EPA reg. no.	Formulation
Fluvalinate	(αRs,2R)-fluvalinate[(RS)-α-cyano-3-phenoxybenzyl(R)-2-[2-chloro-4-(trifluoromethyl) anilino]-3-methyl-butanoate]	Mavrik™	20954-123	22.3% EC
Chlorpyrifos	0,0-Diethyl 0-(3,5,6-trichloro-2-pyridyl)-phosphorothioate	Dursban™	464-590	50% WP
Ethazol	5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole	Truban™	372-43	30% WP
Dicofol	1,1-bis-(4-chlorophenyl)-2,2,2-trichloroethanol	Kelthane™	829-184	18.5% EC
Captan	N-trichloromethylthio-4 cyclohexene-1,2-dicarboximide	Captan™	239-533AA-14775	50% WP
Chlorothalonil	tetrachloroisophthalonitrile	Daconil™	50534-4	75% WP

TABLE 2. PERSONAL DATA

	VG	KM	MS	GG	DD	FR	DP
Sex	M	F	F	M	M	M	F
Age (yr)	23	44	37	26	26	30	30
Height (cm)	170	170	170	183	183	173	176
Weight (kg)	54	58	88	77	79	54	63
Handedness	R	R	L	R	R	L	L
Est. body surface area (m^2)	1.60	1.67	2.07	1.99	2.02	1.62	1.76

TABLE 3. APPLICATION METHODS AND SITES

Subj.	Application method	Location	Greenhouse type
VG	handgun (fine spray)[a]	Parrish, FL[f]	enclosed structure[g]
KM	handgun (fine spray)[b]	Parrish, FL	enclosed structure
MS	handgun (fine spray)[c]	Parrish, FL	enclosed structure
GG	handgun (fine spray)[d]	Parrish, FL	enclosed structure
DD	handgun (coarse spray)	Parrish, FL	open sided structure[h]
FR	tractor-driver (boom spray)[e]	Cortez, FL	open Siran™ structure
DP	drench	Parrish, FL	enclosed structure

[a]applied with pulse fogger on 3/27, 4/22, 4/23, 4/28, 4/29, 5/19

[b]applied with pulse fogger on 4/23

[c]assisted KM on 1/23

[d]applied with pulse fogger on 4/22, 5/20, 5/22

[e]applied with tractor-drawn span sprayer on 8/14 A, B, C

[f]applied at Palma Sola, FL on 11/5, 12/2, 12/17

[g]applied in open Siran™ structure on 11/5

[h]applied in enclosed structure on 9/26 A, B

TABLE 4. PROTECTIVE CLOTHING WORN

	VG	KM[a]	MS[b]	GG[c]	DD[d]	FR	DP
Coverall	X	X	X	X			
Hood	X	X	X	X			
Gloves	X	X	X	X			X
Apron	X	X	X		X		X
Boots	X	X	X	X	X		X
Goggles	X	X	X				
Respirator	X	X	X	X		X	X

[a]wore no apron on 7/24

[b]wore no apron on 8/13, 10/24, 10/30

[c]wore goggles on 5/20

[d]wore coverall and no apron on 10/16 A

TABLE 5a. GAS CHROMATOGRAPH OPERATING CONDITIONS FOR FLUVALINATE

Instrument model	Column	Length/ dia.	Packing/ mesh	Film thickness	Col. gas flow mL/min	Oven temp. °C	Inj. temp. °C	Det. temp. °C
Varian 6000	Fused silica capillary	10 m 0.25 mm ID	DB-1	0.5 micron	N_2 1	220	240	285
Varian 6000	Fused silica capillary	30 m 0.53 mm ID	DB-1	1.5 micron	N_2 30	245	250	300
Perkin-Elmer 8320	Fused silica capillary	15 m 0.25 mm ID	OV-1	0.5 micron	N_2 1	245	255	300

TABLE 5b. GAS CHROMATOGRAPH OPERATING CONDITIONS FOR CHLORPYRIFOS

Instrument model	Column	Length/ dia.	Packing/ mesh	Film thickness	Col. gas flow mL/min	Oven temp. °C	Inj. temp. °C	Det. temp. °C
Hewlitt-Packard 5730A	Glass	1.83 m 2 mm ID	4% SP2100 2% SP2401 100/120 mesh	N/A	N_2 50	170	200	250
Hewlitt-Packard 5730A	Glass	0.91 m 2 mm ID	4% SE30 6% SP2401 100/120 mesh	N/A	N_2 60	170	200	250
Varian 6000	Glass	1.83 m 2 mm ID	4% SP2100 2% SP2401 100/120 mesh	N/A	N_2 50	170	180	230
Varian 6000	Fused silica capillary	30 m 0.53 mm ID	DB-1	1.5 micron	N_2 30	180	200	250
Perkin-Elmer 8320	Fused silica capillary	10 m 0.25 mm ID	OV-1	0.5 micron	H_2 1	180	190	250
Tracor 222	Glass	0.91 m 2 mm ID	4% SE30 6% SP2401 100/120 mesh	N/A	N_2 60	170	210	250
Tracor 550	Glass	0.91 m 2 mm ID	4% SE30 6% SP2401 100/120 mesh	N/A	N_2 60	170	210	220

TABLE 5c. GAS CHROMATOGRAPH OPERATING CONDITIONS FOR ETHAZOL

Instrument model	Column	Length/ dia.	Packing/ mesh	Film thickness	Col. gas flow mL/min	Oven temp. °C	Inj. temp. °C	Det. temp. °C
Hewlitt-Packard 5730A	Glass	1.82 m 2 mm ID	4% SP2100 2% SP2401 100/120 mesh	N/A	N_2 50	130	250	300
Hewlitt-Packard 5730A	Fused silica capillary	15 m 0.53 mm ID	DB-1	1.5 micron	N_2 30	140	200	250
Hewlitt-Packard 5730A	Glass	0.91 m 2 mm ID	4% SE30 6% SP2401 100/120 mesh	N/A	N_2 60	120	200	250
Varian 6000	Glass	1.82 m 2 mm ID	4% SP2100 2% SP2401 100/120 mesh	N/A	N_2 50	130	150	250
Varian 6000	Fused silica capillary	30 m 0.53 mm ID	DB-1	1.5 micron	N_2 30	130	250	250
Tracor 550	Glass	0.91 m 2 mm ID	4% SE30 6% SP2401 100/120 mesh	N/A	N_2 60	120	210	220
Tracor 222	Glass	0.91 m 2 mm ID	4% SE30 6% SP2401 100/120 mesh	N/A	N_2 60	120	200	250

TABLE 5d. GAS CHROMATOGRAPH OPERATING CONDITIONS FOR DICOFOL

Instrument model	Column	Length/ dia.	Packing/ mesh	Film thickness	Col. gas flow mL/min	Oven temp. °C	Inj. temp. °C	Det. temp. °C
Hewlitt-Packard 5730A	Glass	1.82 m 2 mm ID	4% SP2100 2% SP2401 100/120 mesh	N/A	N_2 30	190	250	250
Hewlitt-Packard 5730A	Fused silica capillary	30 m 0.53 mm ID	DB-1	1.5 micron	N_2 30	160	250	250
Varian 6000	Glass	1.82 m 2 mm ID	4% SP2100 2% SP2401 100/120 mesh	N/A	N_2 50	190	250	250
Varian 6000	Fused silica capillary	30 m 0.53 mm ID	DB-1	1.5 micron	N_2 30	190	250	250
Perkin-Elmer 8320	Fused silica capillary	15 m 0.25 mm ID	OV-1	0.5 micron	H_2 1	175	250	250

TABLE 5e. GAS CHROMATOGRAPH OPERATING CONDITIONS FOR CAPTAN

Instrument model	Column	Length/ dia.	Packing/ mesh	Film thickness	Col. gas flow mL/min	Oven temp. °C	Inj. temp. °C	Det. temp. °C
Tracor 222	Glass	0.91 m 2 mm ID	4% SE30 6% SP2401 100/120 mesh	N/A	N_2 55	170	210	250
Tracor 550	Glass	0.91 m 2 mm ID	4% SE30 6% SP2401 100/120 mesh	N/A	N_2 60	170	210	220
Varian 6000	Fused silica capillary	30 m 0.53 mm ID	DB-1	1.5 micron	N_2 30	175	250	250
Perkin-Elmer 8320	Fused silica capillary	15 m 0.25 mm ID	OV-1	0.5 micron	H_2 1	180	190	250

TABLE 5f. GAS CHROMATOGRAPH OPERATING CONDITIONS FOR CHLOROTHALONIL

Instrument model	Column	Length/ dia.	Packing/ mesh	Film thickness	Col. gas flow mL/min	Oven temp. °C	Inj. temp. °C	Det. temp. °C
Tracor 550	Glass	0.91 m 2 mm ID	4% SE30 6% SP2401 100/120 mesh	N/A	N_2 60	170	210	220
Varian 6000	Glass	1.82 m 2 mm ID	4% SP2100 2% SP2401 100/120 mesh	N/A	N_2 50	120	200	250
Varian 6000	Fused silica capillary	30 m 0.53 mm ID	DB-1	1.5 micron	N_2 30	170	250	250
Perkin-Elmer 8320	Fused silica capillary	15 m 0.25 mm ID	OV-1	0.5 micron	H_2 1	205	250	300

TABLE 6. MINIMUM DETECTION LIMITS (MDL) AND MDL-EQUIVALENTS FOR PAD FLUX, HANDWASH ACCUMULATION RATE, AND AIR SAMPLE CONCENTRATION

Compound	MDL (ppb)	MDL-equiv.[a] pad ($\mu g/cm^2 h$)	handwash ($\mu g/h$)	air sample ($\mu g/L$)
Fluvalinate	3	0.001	0.06	0.0003
Chlorpyrifos	2	0.001	0.04	0.0002
Ethazol	6	0.003	0.12	0.0007
Dicofol	2	0.001	0.04	0.0002
Captan	10	0.005	0.20	0.0010
Chlorothalonil	2	0.001	0.04	0.0002

[a]assuming exposure time of 0.5h

TABLE 7a. MEAN[a] VALUES FOR SPRAY RATE, ESTIMATED TOTAL BODY ACCUMULATION RATE (ETBAR), HANDWASHES, AIR SAMPLER (HANDGUNNERS, FINE SPRAY)

Compound	Subj.	Spray rate (kg a.i./h)	ETBAR[b] (µg/h)	Left handwash[c] (µg/h)	Right handwash[c] (µg/h)	Air sampler (µg/L)
Fluvalinate	VG	0.016 ± 0.001 (3)	4,800 ± 4,600 (2)	10 ± 6 (3)	13 ± 6 (3)	0.002 ± 0.001 (3)
	KM	0.040 ± 0.005 (10)	11,000 ± 2,900 (10)	26 ± 8 (10)	71 ± 31 (10)	0.006 ± 0.003 (10)
	MS	0.037 ± 0.007 (9)	43,900 ± 28,500 (9)	28 ± 9 (9)	32 ± 10 (9)	0.006 ± 0.002 (9)
	GG	0.055 ± 0.003 (5)	91,300 ± 17,700 (5)	38 ± 8 (5)	43 ± 7 (5)	0.012 ± 0.005 (5)
Chlorpyrifos	VG	0.076 ± 0.007 (7)	17,500 ± 5,000 (7)	55 ± 53 (7)	280 ± 278 (7)	0.049 ± 0.038 (7)
	KM	0.118 ± 0.008 (7)	19,600 ± 7,500 (7)	11 ± 3 (7)	14 ± 5 (7)	0.075 ± 0.069 (7)
	MS	0.083 ± 0.012 (9)	24,100 ± 6,100 (8)	25 ± 7 (9)	14 ± 4 (9)	0.009 ± 0.004 (9)
Ethazol	VG	0.020 ± 0.003 (2)	305 ± — (1)	0 ± 0 (2)	0 ± 0 (2)	0.087 ± 0.075 (2)
	KM	0.039 ± 0.003 (7)	1,600 ± 300 (7)	1 ± 1 (7)	4 ± 2 (7)	0.113 ± 0.022 (7)
	MS	0.029 ± 0.002 (10)	1,800 ± 700 (9)	1 ± 0 (10)	1 ± 1 (10)	0.055 ± 0.013 (10)
Dicofol	GG	0.044 ± 0.002 (9)	12,600 ± 3,500 (9)	20 ± 10 (9)	19 ± 9 (9)	0.005 ± 0.002 (9)

[a] ± standard error (number of exposures)

[b] does not include handwash (subjects wore gloves)

[c] subjects wore gloves

TABLE 7b. MEAN[a] VALUES FOR SPRAY RATE, ESTIMATED TOTAL BODY ACCUMULATION RATE (ETBAR), HANDWASHES, AIR SAMPLER (HANDGUNNER, COARSE SPRAY)

Compound	Subj.	Spray rate (kg a.i./h)	ETBAR[b] (µg/h)	Left handwash[c] (µg/h)	Right handwash[c] (µg/h)	Air sampler (µg/L)
Fluvalinate	DD	0.039 ± 0.004 (7)	3,200 ± 2,700 (7)	92 ± 52 (7)	97 ± 57 (7)	0.002 ± 0.002 (7)
Chlorpyrifos	DD	0.306 ± 0.023 (8)	21,400 ± 7,100 (7)	1,100 ± 800 (8)	1,100 ± 700 (8)	0.008 ± 0.002 (8)
Ethazol	DD	0.127 ± 0.024 (2)	3,200 ± 2,500 (2)	2 ± 1 (2)	4 ± 2 (2)	0.086 ± 0.051 (2)
Chlorothalonil	DD	0.370 ± 0.100 (3)	103,200 ± 20,300 (2)	1,300 ± 100 (3)	1,900 ± 900 (3)	0.013 ± 0.010 (3)

[a] ± standard error (number of exposures)

[b] includes handwash (subject wore no gloves)

[c] subject wore no gloves

TABLE 7c. MEAN[a] VALUES FOR SPRAY RATE, ESTIMATED TOTAL BODY ACCUMULATION RATE (ETBAR), HANDWASHES, AIR SAMPLER (HANDGUNNERS, PULSE FOG)

Compound	Subj.	Spray rate (kg a.i./h)	ETBAR[b] (µg/h)	Left handwash[c] (µg/h)	Right handwash[c] (µg/h)	Air sampler (µg/L)
Fluvalinate	VG	0.027 ± 0.002 (3)	2,200 ± 1,000 (3)	81 ± 5 (3)	91 ± 18 (3)	0.017 ± 0.013 (3)
	KM	0.028 ± — (1)	1,500 ± — (1)	39 ± — (1)	90 ± — (1)	0.046 ± — (1)
	GG	0.011 ± 0.004 (3)	700 ± 100 (3)	13 ± 7 (3)	39 ± 33 (3)	0.029 ± 0.023 (3)
Chlorpyrifos	VG	0.119 ± 0.008 (3)	700 ± 300 (3)	268 ± 150 (3)	1,200 ± 1,200 (3)	0.043 ± 0.020 (3)
Ethazol	VG	0.038 ± 0.001 (3)	500 ± 100 (3)	2 ± 0 (3)	2 ± 0 (3)	0.073 ± 0.028 (3)

[a] ± standard error (number of exposures)

[b] does not include handwash (subjects wore gloves)

[c] subjects wore gloves

TABLE 7d. MEAN[a] VALUES FOR SPRAY RATE, ESTIMATED TOTAL BODY ACCUMULATION RATE (ETBAR), HANDWASHES, AIR SAMPLER (TRACTOR DRIVER, BOOM SPRAY)

Compound	Subj.	Spray rate (kg a.i./h)	ETBAR[b] (µg/h)	Left handwash[c] (µg/h)	Right handwash[c] (µg/h)	Air sampler (µg/L)
Fluvalinate	FR	0.139 ± 0.009 (7)	300 ± 100 (6)	13 ± 2 (7)	17 ± 6 (7)	0.002 ± 0.001 (7)
Chlorpyrifos	FR	0.962 ± 0.044 (11)	4,500 ± 1,000 (10)	257 ± 76 (11)	332 ± 51 (11)	0.027 ± 0.006 (11)
Captan	FR	0.997 ± 0.067 (7)	2,800 ± 1,000 (6)	95 ± 37 (7)	131 ± 41 (7)	0.015 ± 0.005 (7)
Chlorothalonil	FR	1.350 ± 0.011 (4)	5,200 ± 1,100 (4)	209 ± 20 (4)	340 ± 90 (4)	0.009 ± 0.002 (4)

[a] ± standard error (number of exposures)

[b] includes handwash (subject wore no gloves)

[c] subject wore no gloves

TABLE 7e. MEAN[a] VALUES FOR SPRAY RATE, ESTIMATED TOTAL BODY ACCUMULATION RATE (ETBAR), HANDWASHES, AIR SAMPLER (TRACTOR DRIVER, SPAN SPRAY)

Compound	Subj.	Spray rate (kg a.i./h)	ETBAR[b] (µg/h)	Left handwash[c] (µg/h)	Right handwash[c] (µg/h)	Air sampler (µg/L)
Fluvalinate	FR	0.103 ± 0.002 (3)	21 ± 4 (3)	9 ± 2 (3)	8 ± 2 (3)	0 ± 0 (3)
Chlorpyrifos	FR	0.743 ± 0.013 (3)	700 ± 200 (3)	229 ± 48 (3)	296 ± 204 (3)	0.008 ± 0.001 (3)
Captan	FR	0.743 ± 0.013 (3)	300 ± 100 (3)	43 ± 4 (3)	51 ± 30 (3)	0.006 ± 0.003 (3)

[a] ± standard error (number of exposures)

[b] includes handwash (subject wore no gloves)

[c] subject wore no gloves

TABLE 7f. SPRAY RATE, ESTIMATED TOTAL BODY ACCUMULATION RATE (ETBAR), HANDWASHES, AIR SAMPLER (DRENCHER)

Compound	Subj.	Spray rate (kg a.i./h)	ETBAR[a] (µg/h)	Left handwash[b] (µg/h)	Right handwash[b] (µg/h)	Air sampler (µg/L)
Chlorpyrifos	DP	0.213 ± — (1)	9,400 ± — (1)	82 ± — (1)	34 ± — (1)	0 ± — (1)

[a] does not include handwash (subject wore gloves)

[b] subject wore gloves

TABLE 7g. SPRAY RATE, ESTIMATED TOTAL BODY ACCUMULATION RATE (ETBAR), HANDWASHES, AIR SAMPLER (ASSISTANT)

Compound	Subj.	Spray rate (kg a.i./h)	ETBAR[a] (µg/h)	Left handwash[b] (µg/h)	Right handwash[b] (µg/h)	Air sampler (µg/L)
Chlorpyrifos	MS	0.113 ± — (1)	500 ± — (1)	2 ± — (1)	2 ± — (1)	0.009 ± — (1)

[a] does not include handwash (subject wore gloves)

[b] subject wore gloves

TABLE 8. MEAN TANK MIXES[a], EXPRESSED AS PERCENTS OF PRESUMED TANK MIX

Compound	Handgunners (fine spray)		Handgunner (coarse spray)		Handgunners (pulse fog)	
	Pre-spray	Post-spray	Pre-spray	Post-spray	Pre-spray	Post-spray
Fluvalinate	90 ± 29 (27)	110 ± 28 (27)	51 ± 11 (7)	50 ± 10 (7)	68 ± 28 (7)	72 ± 7 (7)
Chlorpyrifos	16 ± 3 (22)	22 ± 4 (20)	47 ± 13 (8)	48 ± 13 (8)	15 ± 8 (3)	8 ± 2 (3)
Ethazol	28 ± 4 (19)	35 ± 5 (18)	106 ± 25 (2)	112 ± 3 (2)	19 ± 7 (3)	21 ± 7 (3)
Dicofol	57 ± 5 (9)	69 ± 4 (8)				
Captan						
Chlorothalonil			143 ± 39 (3)	91 ± 8 (3)		

[a] ± standard error (number of samples)

(Continued)

TABLE 8 (Continued).

	Tractor driver (boom spray)		Tractor driver (span spray)		Drencher		All
	Pre-spray	Post-spray	Pre-spray	Post-spray	Pre-spray	Post-spray	combined
Fluvalinate	57 ± 11 (7)	53 ± 10 (7)	94 ± 65 (3)	29 ± 5 (3)			81 ± 8 (102)
Chlorpyrifos	45 ± 6 (11)	50 ± 6 (11)	114 ± 23 (3)	58 ± 24 (3)	25 ± —(1)	39 ± —(1)	35 ± 4 (94)
Ethazol							37 ± 5 (47)
Dicofol							63 ± 3 (17)
Captan	30 ± 7 (7)	36 ± 8 (7)	91 ± 6 (3)	66 ± 26 (3)			47 ± 7 (20)
Chlorothalonil	105 ± 6 (4)	109 ± 5 (4)					111 ± 10 (14)

[a] mean ± standard error (number of samples)

TABLE 9a. MEAN[a] ESTIMATED TOTAL BODY ACCUMULATION RATE (ETBAR), NORMALIZED FOR SPRAY RATE (mg DEPOSITED/kg SPRAYED)

Compound	Handgunners[b] (fine spray)	Handgunner[c] (coarse spray)	Handgunners[b] (pulse fog)	Tractor driver[c] (boom spray)	Tractor driver[c] (span spray)	Drencher[b]	Assistant[b]
Fluvalinate	856 ± 221 (26)	81 ± 71 (7)	65 ± 15 (7)	2.1 ± 0.6 (6)	0.20 ± 0.04 (3)		
Chlorpyrifos	229 ± 42 (22)	70 ± 24 (7)	6 ± 2 (3)	4.7 ± 1.1 (10)	0.98 ± 0.23 (3)	44 (1)	4 (1)
Ethazol	39 ± 9 (17)	26 ± 21 (2)	12 ± 4 (3)				
Dicofol	287 ± 81 (9)						
Captan				2.8 ± 1.0 (6)	0.35 ± 0.13 (3)		
Chlorothalonil		279 ± 93 (3)		3.8 ± 0.9 (4)			

[a] ± standard error, with number of exposures in parentheses

[b] does not include handwash (subjects wore gloves)

[c] includes handwash (subjects wore no gloves)

TABLE 9b. MEAN[a] TOTAL HANDWASH, NORMALIZED FOR SPRAY RATE (mg DEPOSITED/kg SPRAYED)

Compound	Handgunners[b] (fine spray)	Handgunner[c] (coarse spray)	Handgunners[b] (pulse fog)
Fluvalinate	1.7 ± 0.3 (27)	5 ± 2 (7)	5 ± 1 (7)
Chlorpyrifos	1.7 ± 1.2 (23)	7 ± 4 (8)	13 ± 10 (3)
Ethazol	0.08 ± 0.02 (19)	0.04 ± 0.02 (2)	0.08 ± 0.01 (3)
Dicofol	0.91 ± 0.30 (9)		
Captan			
Chlorothalonil		9 ± 3 (3)	

[a] ± standard error, with number of exposures in parentheses

[b] subjects wore gloves

[c] subjects wore no gloves

(Continued)

TABLE 9b (Continued).

Compound	Tractor driver[c] (boom spray)	Tractor driver[c] (span spray)	Drencher[b]	Assistant[b]
Fluvalinate	0.21 ± 0.05 (7)	0.17 ± 0.03 (3)		
Chlorpyrifos	0.61 ± 0.10 (11)	0.71 ± 0.28 (3)	0.55 (1)	0.04 (1)
Ethazol				
Dicofol				
Captan	0.23 ± 0.06 (7)	0.13 ± 0.04 (3)		
Chlorothalonil	0.41 ± 0.07 (4)			

[a] ± standard error, with number of exposures in parentheses

[b] subjects wore gloves

[c] subject wore no gloves

TABLE 9c. MEAN[a] AIR SAMPLER DEPOSIT, NORMALIZED FOR SPRAY RATE (mg DEPOSITED/kg SPRAYED)

Compound	Handgunners[b] (fine spray)	Handgunner[c] (coarse spray)	Handgunners[b] (pulse fog)
Fluvalinate	0.033 ± 0.006 (27)	0.0088 ± 0.0074 (7)	0.295 ± 0.141 (7)
Chlorpyrifos	0.082 ± 0.046 (23)	0.0046 ± 0.0011 (8)	0.064 ± 0.031 (3)
Ethazol	0.547 ± 0.232 (19)	0.1213 ± 0.0761 (2)	0.344 ± 0.133 (3)
Dicofol	0.020 ± 0.006 (9)		
Captan			
Chlorothalonil		0.0065 ± 0.0053 (3)	

[a] ± standard error, with number of exposures in parentheses

[b] applications made in enclosed structure

[c] applications made in open sided structure

[d] applications made in open Siran™ structure

(Continued)

TABLE 9c (Continued).

Compound	Tractor driver[d] (boom spray)	Tractor driver[d] (span spray)	Drencher[b]	Assistant[b]
Fluvalinate	0.0019 ± 0.0013 (7)	0 ± 0 (3)		
Chlorpyrifos	0.0051 ± 0.0011 (11)	0.0020 ± 0.0002 (3)	0 (1)	0.0143 (1)
Ethazol				
Dicofol				
Captan	0.0026 ± 0.0008 (7)	0.0015 ± 0.0008 (3)		
Chlorothalonil	0.0012 ± 0.0002 (4)			

[a] ± standard errror, with number of exposures in parentheses

[b] applications made in enclosed structure

[c] applications made in open sided structure

[d] applications made in open Siran™ structure

TABLE 10. SIGNIFICANT DIFFERENCES[a] AMONG COMPOUNDS[b] APPLIED IN TABLE 9a-c

	Handgunners[c] (fine spray)	Handgunners[d] (coarse spray)	Handgunners[c] (pulse fog)	Tractor driver[d] (boom spray)	Tractor driver[d] (span spray)
Normalized ETBAR	F > CS F > E F > D	CL > F CL > CS CL > E	F > CS F > E	none	CS > F CS > CN
Normalized handwash	none	none	none	CS > F CS > CN	none
Normalized air sampler	E > F E > CS E > D	none	none	CS > F CS > CL	CS > F

[a]according to a New Duncan's Multiple Range Test ($p < 0.05$)

[b]fluvalinate (F), chlorpyrifos (CS), ethazol (E), dicofol (D), captan (CN), chlorothalonil (CL)

[c]wore gloves

[d]wore no gloves

TABLE 11a. MEAN[a] EXTERIOR DISTRIBUTION (%) OF ETBAR[b] TO VARIOUS BODY REGIONS (HANDGUNNERS, FINE SPRAY)

Compound	Subj.	No. exp.	Head-neck	Front torso	Back torso	Arms	Upper legs	Lower legs
Fluvalinate	VG	2	2 ± 0	7 ± 1	0 ± 0	6 ± 4	41 ± 1	44 ± 4
	KM	10	2 ± 1	10 ± 6	2 ± 1	9 ± 4	40 ± 9	37 ± 8
	MS	9	1 ± 0	5 ± 1	0 ± 0	14 ± 4	41 ± 9	39 ± 8
	GG	5	0 ± 0	0 ± 0	0 ± 0	1 ± 0	43 ± 0	55 ± 1
Chlorpyrifos	VG	7	0 ± 0	2 ± 1	1 ± 1	2 ± 1	38 ± 9	54 ± 10
	KM	7	1 ± 0	4 ± 2	1 ± 1	1 ± 0	25 ± 8	68 ± 9
	MS	8	0 ± 0	4 ± 2	0 ± 0	5 ± 1	24 ± 7	67 ± 7
Ethazol	VG	1	10	28	13	16	8	25
	KM	7	2 ± 1	13 ± 8	3 ± 1	9 ± 4	20 ± 5	52 ± 8
	MS	9	1 ± 0	7 ± 3	2 ± 1	8 ± 3	21 ± 3	61 ± 5
Dicofol	GG	9	0 ± 0	0 ± 0	1 ± 1	7 ± 7	40 ± 6	52 ± 4

[a] ± standard error

[b] as estimated from outside pads

TABLE 11b. MEAN[a] EXTERIOR DISTRIBUTION (%) OF ETBAR[b] TO VARIOUS BODY REGIONS
(HANDGUNNER, COARSE SPRAY)

Compound	Subj.	No. exp.	Head-neck	Front torso	Back torso	Arms	Left hand	Right hand	Upper legs	Lower legs
Fluvalinate	DD	7	0 ± 0	0 ± 0	0 ± 0	0 ± 0	17 ± 10	12 ± 4	9 ± 6	61 ± 13
Chlorpyrifos	DD	7	0 ± 0	1 ± 0	1 ± 1	3 ± 2	7 ± 5	9 ± 6	24 ± 13	54 ± 15
Ethazol	DD	2	1 ± 1	4 ± 2	1 ± 1	2 ± 2	0 ± 0	1 ± 0	8 ± 2	82 ± 8
Chlorothalonil	DD	2	0 ± 0	1 ± 1	0 ± 0	3 ± 2	2 ± 1	1 ± 0	21 ± 11	74 ± 9

[a] ± standard error

[b] as estimated from outside pads and handwashes

TABLE 11c. MEAN[a] EXTERIOR DISTRIBUTION (%) OF ETBAR[b] TO VARIOUS BODY REGIONS (HANDGUNNERS, PULSE FOG)

Compound	Subj.	No. exp.	Head-neck	Front torso	Back torso	Arms	Upper legs	Lower legs
Fluvalinate	VG	3	8 ± 2	30 ± 17	5 ± 5	13 ± 7	17 ± 3	27 ± 9
	KM	1	4	5	2	5	46	39
	GG	3	3 ± 1	6 ± 2	5 ± 2	3 ± 1	20 ± 5	63 ± 6
Chlorpyrifos	VG	3	4 ± 1	11 ± 2	7 ± 2	15 ± 8	26 ± 7	37 ± 5
Ethazol	VG	3	5 ± 0	13 ± 1	11 ± 1	18 ± 2	24 ± 2	29 ± 3

[a] ± standard error

[b] as estimated from outside pads

TABLE 11d. MEAN[a] EXTERIOR DISTRIBUTION (%) OF ETBAR[b] TO VARIOUS BODY REGIONS (TRACTOR DRIVER, BOOM SPRAYER)

Compound	Subj.	No. exp.	Head-neck	Front torso	Back torso	Arms	Left hand	Right hand	Upper legs	Lower legs
Fluvalinate	FR	6	4 ± 1	2 ± 1	11 ± 7	24 ± 5	5 ± 1	13 ± 6	25 ± 6	15 ± 6
Chlorpyrifos	FR	10	5 ± 1	5 ± 2	7 ± 1	15 ± 5	9 ± 5	9 ± 1	33 ± 5	19 ± 6
Captan	FR	6	8 ± 1	10 ± 5	8 ± 4	15 ± 2	6 ± 4	7 ± 3	27 ± 7	19 ± 12
Chlorothalonil	FR	4	7 ± 1	2 ± 1	12 ± 1	15 ± 3	5 ± 1	6 ± 1	38 ± 4	15 ± 4

[a] ± standard error

[b] as estimated from outside pads and handwashes

TABLE 11e. MEAN[a] EXTERIOR DISTRIBUTION (%) OF ETBAR[b] TO VARIOUS BODY REGIONS (TRACTOR DRIVER, SPAN SPRAY)

Compound	Subj.	No. exp.	Head-neck	Front torso	Back torso	Arms	Left hand	Right hand	Upper legs	Lower legs
Fluvalinate	FR	3	0 ± 0	0 ± 0	0 ± 0	12 ± 12	48 ± 11	40 ± 4	0 ± 0	0 ± 0
Chlorpyrifos	FR	3	3 ± 1	6 ± 2	7 ± 1	4 ± 1	36 ± 12	33 ± 17	6 ± 2	5 ± 1
Captan	FR	3	6 ± 1	18 ± 9	15 ± 15	5 ± 3	20 ± 5	18 ± 5	14 ± 4	5 ± 5

[a] ± standard error

[b] as estimated from outside pads and handwashes

TABLE 11f. EXTERIOR DISTRIBUTION (%) OF ETBAR[a] TO VARIOUS BODY REGIONS OF THE DRENCHER

Compound	Subj.	No. exp.	Head-neck	Front torso	Back torso	Arms	Upper legs	Lower legs
Chlorpyrifos	DP	1	0	0	0	0	87	12

[a]as estimated from outside pads

TABLE 11g. EXTERIOR DISTRIBUTION (%) OF ETBAR[a] TO VARIOUS BODY REGIONS OF THE ASSISTANT

Compound	Subj.	No. exp.	Head-neck	Front torso	Back torso	Arms	Upper legs	Lower legs
Chlorpyrifos	MS	1	3	7	7	11	21	50

[a]as estimated from outside pads

TABLE 12. MEAN[a] DISTRIBUTION (%) OF ETBAR[b] TO VARIOUS BODY REGIONS

	No. exp.	Head-neck	Front torso	Back torso	Arms	Hands	Upper legs	Lower legs
Handgunners (fine spray)	74	1 ± 0	6 ± 1	1 ± 0	8 ± 1	--	32 ± 2	52 ± 2
Handgunner (coarse spray)	18	0 ± 0	1 ± 1	0 ± 0	2 ± 1	18 ± 4	16 ± 5	62 ± 6
Handgunners (pulse fog)	13	5 ± 1	14 ± 3	7 ± 1	12 ± 2	--	24 ± 2	39 ± 2
Tractor driver (boom spray)	26	6 ± 1	5 ± 1	9 ± 2	17 ± 2	16 ± 3	31 ± 3	17 ± 4
Tractor driver (span spray)	9	3 ± 1	8 ± 3	7 ± 5	7 ± 4	65 ± 8	7 ± 1	3 ± 2
Drencher	1	0	0	0	0	--	87	12
Assistant	1	3	7	7	11	--	21	50

[a] ± standard error

[b] as estimated from outside pads

TABLE 13. MEAN[a] TRANSMITTANCE[b] TO INSIDE PADS, ALL SUBJECTS

	Fluvalinate	Chlorpyrifos	Ethazol	Dicofol	Chlorothalonil
Chest, covered by					
coverall only	0.02 ± 0.02 (11)	0.12 ± 0.08 (2)	—	0.01 ± 0.01 (9)	—
apron only	—	0.05 ± — (1)	—	—	—
coverall plus apron	0[c] ± 0 (24)	0.09 ± 0.04 (24)	0.23 ± 0.04 (20)	—	—
Forearms, covered by					
coverall only	0.04 ± 0.03 (33)	0.12 ± 0.06 (26)	0.23 ± 0.04 (20)	0.12 ± 0.05 (9)	—
Thighs, covered by					
coverall only	0.01 ± 0.01 (11)	0.01 ± 0.00 (2)	—	0 ± 0 (9)	—
apron only	0.22 ± 0.13 (4)	0.11 ± 0.11 (6)	0.52 ± 0.31 (3)	—	0.01 ± 0.01 (3)
coverall plus apron	0 ± 0 (24)	0.02 ± 0.01 (24)	0.15 ± 0.03 (22)	—	—
Shins, covered by					
boots only	0 ± 0 (7)	0 ± 0 (8)	0.02 ± 0.02 (2)	—	0 ± 0 (3)
coverall plus boots	0.04 ± 0.02 (31)	0.04 ± 0.03 (26)	0.02 ± 0.01 (20)	0 ± 0 (9)	—

[a] ± standard error (number of exposures)

[b] ratio of inside pad flux to outside pad flux

[c] indicates < 0.005

TABLE 14. SIGNIFICANT DIFFERENCES[a] IN TRANSMITTANCE AMONG COMPOUNDS OF TABLE 13

Chest covered by	
coverall only	No differences confirmed
apron only	No differences confirmed
coverall plus apron	Ethazol > Fluvalinate, Ethazol > Chlorpyrifos
Forearms, covered by	
coverall only	Ethazol > Fluvalinate
Thighs, covered by	
coverall only	No differences confirmed
apron only	No differences confirmed
coverall plus apron	Ethazol > Fluvalinate, Ethazol > Chlorpyrifos
Shins, covered by	
boots only	No differences confirmed
coverall plus boots	No differences confirmed

[a]according to a Duncan's New Multiple Range Test ($p < 0.05$)

TABLE 15. OUTLIERS[a] FROM TRANSMITTANCE CALCULATIONS

Compound	Subject	Date	Location	Outside flux ($\mu g/cm^2 h$)	Inside flux ($\mu g/cm^2 h$)
Fluvalinate	DD	9/9 A	Thighs	0.001	0.003
	DD	10/16 C	Thighs	ND	0.018
Chlorpyrifos	VG	4/23	Chest	0.013	0.017
	VG	4/23	Forearms	0.008	0.336
	VG	4/23	Thighs	0.067	0.329
	VG	4/23	Shins	0.072	0.200
	DD	10/16 A	Chest	0.004	0.012
	DD	10/16 A	Forearms	0.007	0.005
	DD	10/16 A	Thighs	0.009	0.014
	DD	10/16 A	Shins	0.010	0.003
	DD	10/16 B	Thighs	0.011	0.030
	DD	10/16 C	Thighs	0.033	0.054
	DP	7/23	Chest	0.007	0.009
	DP	7/23	Forearms	0.010	0.016
Ethazol	MS	4/7	Chest	0.003	0.005
	MS	4/15	Chest	0.003	0.004
	MS	4/15	Forearms	0.002	0.004
	KM	6/4	Chest	0.007	0.012

[a] "outliers" defined as those transmittances differing by at least five standard deviations from the mean of the other transmittances in the same group, thus assuring $p < 10^{-6}$ error in excluding the outlier.

APPENDIX A. TABLE A-1. SUBJECT VG, FLUVALINATE

	7/25/85	8/28	3/27/86	4/22	5/19	5/29
Exposure period (h)	0.933	0.833	0.450	0.550	0.433	0.750
Spray rate (kg a.i./h)	0.017	0.015	0.028	0.023	0.029	0.017
Flux ($\mu g/cm^2h$)						
Outside pads						
Back	ND	0.007	ND	ND	0.105	0.030
Chest	0.005	0.194	0.034	0.908	0.064	0.030
Shoulders	0.004	0.228	0.032	0.020	0.332	0.097
Forearms	0.008	0.095	0.034	0.010	0.216	—
Thighs	0.026	1.303	0.040	0.160	0.138	0.998
Shins	0.023	1.465	0.086	0.230	0.112	0.745
Inside pads						
Chest	ND	ND	ND	ND	ND	ND
Forearms	ND	0.002	0.018	0.002	0.003	0.004
Thighs	ND	0.001	ND	0.004	0.002	ND
Shins	0.009	ND	ND	0.004	0.001	ND
Accumulation rate ($\mu g/h$)						
Left handwash	0.3	9.5	75.2	91.2	77.3	19.9
Right handwash	1.4	22.6	80.8	126.4	66.3	15.3
Est. total body	185.7	9458.8	590.0	4119.8	1989.1	—
Distribution (%) of est. total body accum. rate						
Head-neck	2	2	5	7	13	—
Front torso	8	6	17	63	9	—
Back torso	0	0	0	0	15	—
Arms	10	2	13	1	24	—
Upper legs	41	40	20	11	20	—
Lower legs	40	49	46	18	18	—
Air sampler ($\mu g/L$)	ND	0.0040	ND	0.0414	0.0086	0.0023
Tank mixture (ppm a.i.)						
As mixed	67	111	836	836	836	111
Pre-spray	ND	ND	ND	814	492	370
Post-spray	14	67	750	550	500	373
Quality assurance						
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND	ND
Fortified pad (% rec.)	6	92	66	104	33	30
Handled pad ($\mu g/cm^2h$)	—	—	ND	ND	ND	ND
Blank handwash ($\mu g/h$)	ND	ND	ND	ND	ND	ND
Fortified handwash (% rec.)	34	131	30	66	37	88
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	0.0007	ND	ND
Fortified air sampler plug (% rec.)	18	52	56	48	22	69
Mean temperature (°C)	26	28	28	23	31	33
Mean relative humidity (%)	89	80	57	51	65	50

TABLE A-2. SUBJECT KM, FLUVALINATE

	7/24/85	11/14	11/27	3/12/86	3/26
Exposure period (h)	0.367	0.467	0.333	0.483	0.450
Spray rate (kg a.i./h)	0.017	0.041	0.057	0.052	0.028
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	ND	0.047	ND	0.214	ND
Chest	ND	0.019	0.084	0.016	0.044
Shoulders	ND	0.030	0.013	0.042	ND
Forearms	0.019	0.122	0.031	0.222	0.264
Thighs	0.941	0.012	0.568	3.480	2.282
Shins	0.056	0.126	2.373	7.468	2.960
Inside pads					
Chest	ND	ND	ND	ND	ND
Forearms	ND	ND	ND	0.006	ND
Thighs	ND	ND	ND	ND	ND
Shins	ND	ND	1.377	ND	ND
Accumulation rate ($\mu g/h$)					
Left handwash	ND	1.7	25.6	9.4	2.2
Right handwash	0.9	12.7	43.6	13.6	2.8
Est. total body	3028.4	914.8	8927.8	33354.0	16174.0
Distribution (%) of est. total body accum. rate					
Head-neck	0	4	0	0	8
Front torso	0	6	3	0	1
Back torso	0	15	0	2	0
Arms	1	31	1	2	4
Upper legs	93	4	19	31	42
Lower legs	5	40	77	65	53
Air sampler ($\mu g/L$)	ND	0.0017	0.0293	0.0062	0.0120
Tank mixture (ppm a.i.)					
As mixed	67	167	167	223	111
Pre-spray	46	56	85	350	396
Post-spray	46	126	70	364	398
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Fortified pad (% rec.)	17	24	16	92	56
Handled pad ($\mu g/cm^2h$)	—	—	—	ND	ND
Blank handwash ($\mu g/h$)	ND	ND	ND	ND	ND
Fortified handwash (% rec.)	17	41	62	108	42
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	ND	ND
Fortified air sampler plug (% rec.)	—	33	41	46	36
Mean temperature (°C)	32	29	27	34	26
Mean relative humidity (%)	70	69	80	67	73

(Continued)

TABLE A-2 (Continued).

	4/2/86	4/10	4/23	5/6	5/8	6/4
Exposure period (h)	0.500	0.400	0.450	0.483	0.567	0.400
Spray rate (kg a.i./h)	0.025	0.032	0.028	0.052	0.033	0.063
Flux ($\mu g/cm^2h$)						
Outside pads						
Back	ND	ND	0.008	0.004	ND	0.074
Chest	0.066	0.048	0.026	0.554	1.428	ND
Shoulders	0.004	0.006	0.084	0.040	0.002	0.041
Forearms	0.160	1.778	0.030	0.446	0.088	0.041
Thighs	0.672	1.938	0.228	0.808	0.560	3.722
Shins	1.506	1.302	0.202	0.374	0.258	0.831
Inside pads						
Chest	ND	ND	ND	ND	ND	ND
Forearms	ND	0.008	ND	0.006	ND	ND
Thighs	ND	ND	ND	ND	ND	ND
Shins	ND	ND	ND	ND	ND	ND
Accumulation rate ($\mu g/h$)						
Left handwash	54.2	31.2	38.6	22.0	77.6	40.1
Right handwash	56.4	206.8	89.8	55.4	26.2	291.0
Est. total body	6965.8	13882.8	1498.4	6350.4	7194.6	13921.0
Distribution (%) of est. total body accum. rate						
Head-neck	0	0	4	3	6	0
Front torso	3	1	5	25	58	0
Back torso	0	0	2	0	0	2
Arms	5	30	5	16	3	1
Upper legs	29	42	46	38	23	80
Lower legs	62	27	39	17	10	17
Air sampler ($\mu g/L$)	0.0016	0.0026	0.0458	0.0024	0.0008	ND
Tank mixture (ppm a.i.)						
As mixed	111	111	836	223	167	267
Pre-spray	76	132	418	448	68	368
Post-spray	96	110	372	362	66	379
Quality assurance						
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND	—
Fortified pad (% rec.)	80	64	80	80	46	123
Handled pad ($\mu g/cm^2h$)	ND	ND	—	ND	ND	ND
Blank handwash ($\mu g/h$)	ND	ND	ND	ND	ND	ND
Fortified handwash (% rec.)	78	12	74	78	62	49
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	ND	ND	ND
Fortified air sampler plug (% rec.)	64	68	42	36	44	34
Mean temperature (°C)	35	25	31	24	34	35
Mean relative humidity (%)	48	31	35	53	54	56

TABLE A-3. SUBJECT MS, FLUVALINATE

	8/1/85	9/10	10/30	2/12/86	2/26
Exposure period (h)	0.750	0.567	0.500	0.583	0.567
Spray rate (kg a.i./h)	0.017	0.022	0.038	0.043	0.045
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.002	ND	ND	0.022	0.010
Chest	0.029	0.066	0.020	0.080	0.088
Shoulders	0.007	ND	0.001	0.078	0.022
Forearms	0.132	0.141	0.023	0.684	0.602
Thighs	0.309	0.227	0.825	1.638	61.692
Shins	0.954	0.281	0.040	2.220	10.388
Inside pads					
Chest	ND	ND	ND	ND	ND
Forearms	ND	ND	0.006	ND	0.004
Thighs	ND	ND	0.003	0.002	ND
Shins	ND	ND	ND	ND	ND
Accumulation rate ($\mu g/h$)					
Left handwash	1.7	6.4	27.0	12.8	17.8
Right handwash	3.1	5.4	17.0	25.0	14.2
Est. total body	5098.1	2525.6	3361.3	16525.6	269265.0
Distribution (%) of est. total body accum. rate					
Head-neck	0	1	0	1	0
Front torso	2	9	2	2	0
Back torso	0	0	0	0	0
Arms	8	16	2	12	1
Upper legs	23	33	91	37	85
Lower legs	67	40	4	48	14
Air sampler ($\mu g/L$)	ND	0.0029	0.0017	0.0106	0.0062
Tank mixture (ppm a.i.)					
As mixed	67	111	167	191	223
Pre-spray	ND	30	14	28	206
Post-spray	36	62	92	618	296
Quality assurance					
Blank pad ($\mu g/cm^2h$)	0.001	ND	ND	ND	ND
Fortified pad (% rec.)	63	32	160	38	104
Handled pad ($\mu g/cm^2h$)	--	--	--	ND	ND
Blank handwash ($\mu g/h$)	ND	ND	ND	ND	ND
Fortified handwash (% rec.)	121	6	119	38	108
Blank air sampler plug ($\mu g/L$)	ND	ND	0.0016	ND	ND
Fortified air sampler plug (% rec.)	81	13	47	16	40
Mean temperature (°C)	33	32	27	32	33
Mean relative humidity (%)	68	65	86	43	47

(Continued)

TABLE A-3 (Continued).

	4/1/86	4/9	5/15	5/27
Exposure period (h)	0.650	0.550	0.467	0.333
Spray rate (kg a.i./h)	0.019	0.023	0.054	0.076
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	ND	ND	ND	ND
Chest	0.872	0.728	0.174	0.301
Shoulders	0.054	0.040	0.007	0.040
Forearms	1.056	2.530	1.112	1.498
Thighs	1.396	3.484	0.581	0.718
Shins	2.734	2.664	0.712	7.507
Inside pads				
Chest	ND	ND	ND	ND
Forearms	0.002	0.006	0.001	ND
Thighs	ND	ND	0.003	ND
Shins	0.006	ND	ND	ND
Accumulation rate ($\mu g/h$)				
Left handwash	48.6	14.6	89.2	30.0
Right handwash	82.4	16.0	50.7	75.2
Est. total body	21591.0	32803.0	8640.2	35252.7
Distribution (%) of est. total body accum. rate				
Head-neck	1	1	1	0
Front torso	14	8	7	3
Back torso	0	0	0	0
Arms	14	22	37	12
Upper legs	24	40	25	8
Lower legs	46	29	30	77
Air sampler ($\mu g/L$)	0.0110	0.0152	0.0029	0.0042
Tank mixture (ppm a.i.)				
As mixed	111	111	223	223
Pre-spray	34	160	134	55
Post-spray	54	112	50	127
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND
Fortified pad (% rec.)	160	78	33	95
Handled pad ($\mu g/cm^2h$)	0.038	ND	ND	ND
Blank handwash ($\mu g/h$)	ND	ND	ND	ND
Fortified handwash (% rec.)	94	76	6	71
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	ND
Fortified air sampler plug (% rec.)	56	34	48	62
Mean temperature (°C)	32	28	29	33
Mean relative humidity (%)	45	63	58	52

TABLE A-4. SUBJECT GG, FLUVALINATE

	3/25/86	3/31	4/1	4/3
Exposure period (h)	0.683	0.767	0.750	1.000
Spray rate (kg a.i./h)	0.056	0.049	0.067	0.051
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	0.026	0.032	0.044	0.028
Chest	0.034	0.034	0.062	0.068
Shoulders	0.080	0.090	0.078	0.096
Forearms	0.188	0.264	0.392	0.262
Thighs	6.210	15.674	9.596	8.588
Shins	6.998	18.948	11.560	6.144
Inside pads				
Chest	ND	ND	0.002	ND
Forearms	0.002	0.008	0.002	0.004
Thighs	0.088	1.436	ND	0.088
Shins	ND	0.002	0.596	0.068
Accumulation rate ($\mu g/h$)				
Left handwash	25.8	64.4	26.4	51.8
Right handwash	22.2	46.4	32.0	48.6
Est. total body	51059.8	132931.2	83410.8	56754.6
Distribution (%) of est. total body accum. rate				
Head-neck	0	0	0	0
Front torso	0	0	0	0
Back torso	0	0	0	0
Arms	1	1	1	1
Upper legs	44	43	43	43
Lower legs	54	56	55	55
Air sampler ($\mu g/L$)	0.0166	0.0234	0.0176	ND
Tank mixture (ppm a.i.)				
As mixed	201	201	223	223
Pre-spray	312	176	290	184
Post-spray	320	234	90	234
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND
Fortified pad (% rec.)	84	80	74	68
Handled pad ($\mu g/cm^2h$)	ND	ND	0.002	ND
Blank handwash ($\mu g/h$)	ND	ND	ND	ND
Fortified handwash (% rec.)	94	88	88	68
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	ND
Fortified air sampler plug (% rec.)	60	52	54	68
Mean temperature (°C)	25	25	27	27
Mean relative humidity (%)	51	49	53	56

(Continued)

TABLE A-4 (Continued).

	4/4/86	4/22	5/20	5/22
Exposure period (h)	0.983	0.683	0.817	0.683
Spray rate (kg a.i./h)	0.051	0.019	0.008	0.006
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	0.020	0.018	0.009	0.002
Chest	0.122	0.022	0.009	0.006
Shoulders	0.036	0.032	0.017	ND
Forearms	0.518	0.014	0.005	0.002
Thighs	15.038	0.138	0.042	0.119
Shins	19.098	0.024	0.075	0.029
Inside pads				
Chest	ND	ND	0.002	ND
Forearms	0.002	0.004	ND	ND
Thighs	0.362	ND	ND	ND
Shins	ND	ND	ND	ND
Accumulation rate ($\mu g/h$)				
Left handwash	23.8	24.6	0.9	10.6
Right handwash	65.2	104.2	1.2	10.3
Est. total body	132159.0	822.6	548.7	583.4
Distribution (%) of est. total body accum. rate				
Head-neck	0	5	4	1
Front torso	0	10	6	3
Back torso	0	8	6	1
Arms	1	5	3	1
Upper legs	42	12	28	19
Lower legs	57	61	54	75
Air sampler ($\mu g/L$)	0.0004	0.0750	0.0097	0.0036
Tank mixture (ppm a.i.)				
As mixed	223	423	214	213
Pre-spray	34	282	391	46
Post-spray	106	266	210	176
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND
Fortified pad (% rec.)	52	68	57	68
Handled pad ($\mu g/cm^2h$)	ND	ND	ND	ND
Blank handwash ($\mu g/h$)	ND	ND	ND	ND
Fortified handwash (% rec.)	14	76	75	78
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	ND
Fortified air sampler plug (% rec.)	38	52	40	46
Mean temperature (°C)	26	28	27	29
Mean relative humidity (%)	61	50	74	53

TABLE A-5. SUBJECT VG, CHLORPYRIFOS

	7/23/85	7/30	8/22	10/10	11/5
Exposure period (h)	0.717	0.567	0.683	0.667	0.833
Spray rate (kg a.i./h)	0.059	0.075	0.062	0.064	0.085
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.007	0.014	0.004	0.029	0.002
Chest	0.327	0.043	0.071	0.071	ND
Shoulders	0.124	0.018	0.021	0.020	0.003
Forearms	0.186	0.336	0.172	0.147	0.010
Thighs	1.234	5.840	1.408	0.496	0.065
Shins	6.450	5.403	3.205	1.900	0.163
Inside pads					
Chest	0.001	0.003	0.006	ND	ND
Forearms	0.001	0.003	ND	0.002	0.003
Thighs	0.001	0.001	ND	ND	ND
Shins	ND	ND	ND	0.010	ND
Accumulation rate ($\mu g/h$)					
Left handwash	0.8	1.5	0.5	2.2	1.3
Right handwash	1.5	0.8	0.2	1.8	2.2
Est. total body	25586.5	35205.5	14914.7	8125.8	737.1
Distribution (%) of est. total body accum. rate					
Head-neck	1	0	0	1	0
Front torso	4	0	1	3	0
Back torso	0	0	0	1	1
Arms	2	2	3	4	3
Upper legs	14	49	28	18	26
Lower legs	80	49	68	74	70
Air sampler ($\mu g/L$)	0.0017	0.0067	0.0014	0.2754	0.0163
Tank mixture (ppm a.i.)					
As mixed	375	375	375	375	468
Pre-spray	4	124	103	151	ND
Post-spray	93	121	120	199	16
Quality assurance					
Blank pad ($\mu g/cm^2h$)	0.002	0.003	ND	ND	ND
Fortified pad (% rec.)	115	113	56	78	80
Handled pad ($\mu g/cm^2h$)	--	--	--	--	--
Blank handwash ($\mu g/h$)	ND	0.1	1.2	0.1	ND
Fortified handwash (% rec.)	69	112	64	110	65
Blank air sampler plug ($\mu g/L$)	ND	0.0007	0.0020	ND	0.0069
Fortified air sampler plug (% rec.)	70	108	91	46	89
Mean temperature (°C)	29	26	31	26	17
Mean relative humidity (%)	74	89	72	89	78

(Continued)

TABLE A-5 (Continued).

	12/2/85	12/5	4/23/86	4/28	4/29
Exposure period (h)	0.367	0.517	0.550	0.433	0.467
Spray rate (kg a.i./h)	0.077	0.110	0.103	0.131	0.122
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.013	0.057	0.005	0.038	0.013
Chest	0.040	0.038	0.013	0.059	0.017
Shoulders	0.034	0.016	0.013	0.065	0.012
Forearms	0.092	0.891	0.008	0.062	0.051
Thighs	8.749	1.179	0.067	0.101	0.020
Shins	1.441	0.449	0.072	0.149	0.032
Inside pads					
Chest	0.012	ND	0.017	0.004	0.016
Forearms	0.041	ND	0.336	0.006	0.007
Thighs	0.509	ND	0.329	0.016	0.004
Shins	0.221	0.003	0.200	0.004	0.004
Accumulation rate ($\mu g/h$)					
Left handwash	374.8	5.7	567.3	139.3	97.0
Right handwash	1945.4	7.3	3594.3	122.5	25.5
Est. total body	30670.6	7206.1	506.3	1252.6	374.3
Distribution (%) of est. total body accum. rate					
Head-neck	0	1	3	6	4
Front torso	0	2	7	13	13
Back torso	0	2	3	9	10
Arms	1	28	3	11	30
Upper legs	84	48	39	24	15
Lower legs	15	20	45	38	27
Air sampler ($\mu g/L$)	0.0257	0.0131	0.0164	0.0828	0.0285
Tank mixture (ppm a.i.)					
As mixed	375	375	3747	3747	3747
Pre-spray	2	6	367	1152	174
Post-spray	—	39	339	396	184
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	0.003	0.001	0.002	0.005
Fortified pad (% rec.)	87	63	65	72	88
Handled pad ($\mu g/cm^2h$)	—	—	—	0.001	0.001
Blank handwash ($\mu g/h$)	ND	ND	ND	0.3	ND
Fortified handwash (% rec.)	96	62	76	128	99
Blank air sampler plug ($\mu g/L$)	ND	ND	0.0033	ND	0.0057
Fortified air sampler plug (% rec.)	84	58	64	74	90
Mean temperature (°C)	24	22	24	29	30
Mean relative humidity (%)	83	89	38	45	45

TABLE A-6. SUBJECT KM, CHLORPYRIFOS

	12/10/85	12/11	1/23/86	2/25
Exposure period (h)	0.367	0.283	0.500	0.433
Spray rate (kg a.i./h)	0.154	0.125	0.113	0.098
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	0.036	ND	0.007	0.003
Chest	0.044	0.005	0.008	0.007
Shoulders	0.018	0.003	0.008	0.004
Forearms	0.021	0.003	0.005	0.015
Thighs	0.101	0.090	0.044	0.684
Shins	3.073	0.072	0.058	3.658
Inside pads				
Chest	ND	ND	ND	ND
Forearms	0.004	0.004	ND	0.002
Thighs	0.017	ND	ND	ND
Shins	0.120	0.047	0.002	ND
Accumulation rate ($\mu g/h$)				
Left handwash	23.2	18.1	15.9	4.7
Right handwash	10.1	43.9	2.1	4.7
Est. total body	9527.0	503.4	362.1	12720.0
Distribution (%) of est. total body accum. rate				
Head-neck	0	1	2	0
Front torso	1	3	6	0
Back torso	1	0	5	0
Arms	1	1	3	0
Upper legs	3	53	36	16
Lower legs	94	41	47	83
Air sampler ($\mu g/L$)	0.0116	ND	0.0043	ND
Tank mixture (ppm a.i.)				
As mixed	500	625	375	511
Pre-spray	58	107	95	172
Post-spray	14	63	39	3
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND
Fortified pad (% rec.)	21	93	90	97
Handled pad ($\mu g/cm^2h$)	—	—	—	ND
Blank handwash ($\mu g/h$)	1.4	ND	ND	ND
Fortified handwash (% rec.)	95	75	70	89
Blank air sampler plug ($\mu g/L$)	0.0072	ND	ND	ND
Fortified air sampler plug (% rec.)	51	40	55	68
Mean temperature (°C)	26	26	27	32
Mean relative humidity (%)	69	81	43	43

(Continued)

TABLE A-6 (Continued).

	3/5/86	5/9	5/20
Exposure period (h)	0.450	0.500	0.333
Spray rate (kg a.i./h)	0.126	0.085	0.128
Flux ($\mu g/cm^2h$)			
Outside pads			
Back	0.025	0.010	0.006
Chest	0.008	0.063	3.205
Shoulders	0.004	0.023	0.020
Forearms	0.053	0.212	0.826
Thighs	0.702	5.461	1.224
Shins	8.217	5.286	13.718
Inside pads			
Chest	ND	0.003	ND
Forearms	ND	0.003	ND
Thighs	0.001	0.003	ND
Shins	ND	0.001	ND
Accumulation rate ($\mu g/h$)			
Left handwash	7.3	4.3	4.8
Right handwash	19.5	11.0	6.4
Est. total body	26152.6	32435.0	55625.0
Distribution (%) of est. total body accum. rate			
Head-neck	0	0	2
Front torso	0	1	17
Back torso	0	0	0
Arms	0	2	3
Upper legs	8	50	7
Lower legs	91	47	71
Air sampler ($\mu g/L$)	0.0054	0.0094	0.4909
Tank mixture (ppm a.i.)			
As mixed	500	562	562
Pre-spray	13	168	246
Post-spray	14	140	424
Quality assurance			
Blank pad ($\mu g/cm^2h$)	0.004	ND	ND
Fortified pad (% rec.)	106	70	83
Handled pad ($\mu g/cm^2h$)	0.029	0.002	ND
Blank handwash ($\mu g/h$)	ND	ND	ND
Fortified handwash (% rec.)	110	79	104
Blank air sampler plug ($\mu g/L$)	ND	ND	ND
Fortified air sampler plug (% rec.)	68	87	144
Mean temperature (°C)	38	28	27
Mean relative humidity (%)	34	76	70

TABLE A-7. SUBJECT MS, CHLORPYRIFOS

	8/13/85	9/17	10/24	12/3	1/23/86
Exposure period (h)	0.383	0.583	0.533	0.467	0.500
Spray rate (kg a.i./h)	0.111	0.049	0.053	0.091	0.113
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.009	0.006	0.015	ND	0.010
Chest	0.040	0.039	0.030	—	0.010
Shoulders	0.005	0.005	0.019	0.010	0.010
Forearms	0.554	0.159	2.274	0.018	0.018
Thighs	0.388	0.486	7.134	0.026	0.026
Shins	5.544	3.941	8.142	0.066	0.066
Inside pads					
Chest	0.008	0.003	0.001	ND	0.005
Forearms	0.019	0.004	0.024	ND	0.003
Thighs	0.003	ND	0.021	ND	ND
Shins	0.002	ND	ND	ND	ND
Accumulation rate ($\mu g/h$)					
Left handwash	5.5	35.0	31.0	32.3	2.3
Right handwash	12.5	12.3	38.3	8.5	2.5
Est. total body	23203.9	16633.2	62645.1	—	472.8
Distribution (%) of est. total body accum. rate					
Head-neck	0	0	0	—	3
Front torso	1	1	0	—	7
Back torso	0	0	0	—	7
Arms	7	3	11	—	11
Upper legs	6	11	42	—	21
Lower legs	86	85	47	—	50
Air sampler ($\mu g/L$)	0.0120	0.0037	0.0071	ND	0.0085
Tank mixture (ppm a.i.)					
As mixed	321	250	300	450	375
Pre-spray	135	41	59	—	95
Post-spray	110	70	—	—	39
Quality assurance					
Blank pad ($\mu g/cm^2h$)	0.016	ND	ND	ND	ND
Fortified pad (% rec.)	100	69	86	77	72
Handled pad ($\mu g/cm^2h$)	—	—	—	—	—
Blank handwash ($\mu g/h$)	ND	ND	ND	ND	ND
Fortified handwash (% rec.)	74	76	69	27	70
Blank air sampler plug ($\mu g/L$)	0.0073	ND	ND	ND	ND
Fortified air sampler plug (% rec.)	87	65	54	64	55
Mean temperature (°C)	26	32	28	26	27
Mean relative humidity (%)	90	70	80	76	43

(Continued)

TABLE A-7 (Continued).

	1/28/86	4/15	4/16	5/7	5/14
Exposure period (h)	0.400	0.567	0.500	0.467	0.550
Spray rate (kg a.i./h)	0.142	0.050	0.057	0.091	0.103
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.004	0.002	0.018	0.004	0.011
Chest	0.007	0.057	0.037	0.071	0.726
Shoulders	0.004	0.028	0.007	0.011	0.021
Forearms	0.193	0.072	0.127	0.133	0.241
Thighs	0.402	1.905	3.589	0.126	0.837
Shins	7.151	4.208	2.492	0.847	1.588
Inside pads					
Chest	ND	ND	0.002	0.005	0.004
Forearms	0.005	0.002	0.009	0.011	0.004
Thighs	ND	0.001	0.001	0.002	0.001
Shins	ND	ND	0.001	ND	0.001
Accumulation rate ($\mu g/h$)					
Left handwash	7.1	4.0	22.6	9.5	73.9
Right handwash	1.8	6.6	17.9	3.3	27.5
Est. total body	27836.9	22705.0	22929.8	4205.8	12463.0
Distribution (%) of est. total body accum. rate					
Head-neck	0	0	0	1	2
Front torso	0	1	1	6	21
Back torso	0	0	0	0	0
Arms	2	1	2	9	6
Upper legs	5	31	58	11	25
Lower legs	92	67	39	73	46
Air sampler ($\mu g/L$)	ND	0.0026	0.0112	0.0095	0.0339
Tank mixture (ppm a.i.)					
As mixed	428	375	500	562	500
Pre-spray	3	ND	ND	24	ND
Post-spray	7	42	112	243	96
Quality assurance					
Blank pad ($\mu g/cm^2h$)	0.014	0.002	ND	0.004	0.002
Fortified pad (% rec.)	86	82	72	67	69
Handled pad ($\mu g/cm^2h$)	—	0.044	ND	ND	0.001
Blank handwash ($\mu g/h$)	ND	ND	0.2	0.2	ND
Fortified handwash (% rec.)	73	58	76	65	85
Blank air sampler plug ($\mu g/L$)	ND	0.0008	0.0018	0.0027	ND
Fortified air sampler plug (% rec.)	57	86	74	66	82
Mean temperature (°C)	22	33	25	32	29
Mean relative humidity (%)	—	53	58	60	58

TABLE A-8. SUBJECT VG, ETHAZOL

	4/28/86	4/29	5/19	5/27	5/29
Exposure period (h)	0.433	0.467	0.433	0.983	0.750
Spray rate (kg a.i./h)	0.039	0.036	0.039	0.017	0.023
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.015	0.006	0.031	0.013	0.012
Chest	0.018	0.009	0.033	0.030	0.021
Shoulders	0.026	0.008	0.029	0.029	0.025
Forearms	0.032	0.014	0.065	0.022	—
Thighs	0.043	0.017	0.043	0.008	0.040
Shins	0.055	0.015	0.057	0.024	0.090
Inside pads					
Chest	0.002	0.001	0.008	0.005	0.002
Forearms	0.009	0.001	0.007	0.005	0.005
Thighs	0.007	0.010	0.010	0.002	0.006
Shins	0.001	0.002	0.002	0.001	0.002
Accumulation rate ($\mu g/h$)					
Left handwash	1.6	1.9	1.1	0.1	0.2
Right handwash	2.7	1.4	1.0	0.1	0.6
Est. total body	494.6	182.2	677.3	305.3	—
Distribution (%) of est. total body accum. rate					
Head-neck	5	5	6	10	—
Front torso	11	14	14	28	—
Back torso	9	10	13	13	—
Arms	15	18	22	16	—
Upper legs	25	27	19	8	—
Lower legs	35	26	27	25	—
Air sampler ($\mu g/L$)	0.0744	0.0231	0.1202	0.0119	0.1610
Tank mixture (ppm a.i.)					
As mixed	1124	1124	1124	112	150
Pre-spray	246	67	342	55	52
Post-spray	208	133	382	61	52
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Fortified pad (% rec.)	56	ND	33	51	45
Handled pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Blank handwash ($\mu g/h$)	0.1	0.1	ND	ND	0.1
Fortified handwash (% rec.)	20	31	71	42	5
Blank air sampler plug ($\mu g/L$)	0.0002	0.0012	ND	0.0003	ND
Fortified air sampler plug (% rec.)	38	1	83	19	117
Mean temperature (°C)	29	30	31	32	33
Mean relative humidity (%)	45	45	65	52	50

TABLE A-9. SUBJECT KM, ETHAZOL

	2/7/86	3/5	3/12	4/8
Exposure period (h)	0.667	0.450	0.483	0.517
Spray rate (kg a.i./h)	0.026	0.038	0.035	0.033
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	0.005	0.021	0.016	0.008
Chest	0.023	0.020	0.010	0.006
Shoulders	0.010	0.017	0.012	0.011
Forearms	0.020	0.053	0.040	0.112
Thighs	0.157	0.056	0.093	0.089
Shins	0.484	0.675	0.184	0.078
Inside pads				
Chest	0.001	ND	0.001	0.003
Forearms	0.003	0.008	0.002	0.004
Thighs	0.002	0.006	0.003	0.006
Shins	0.001	ND	0.001	0.001
Accumulation rate ($\mu g/h$)				
Left handwash	2.7	5.1	0.1	0.2
Right handwash	1.8	12.4	0.1	0.3
Est. total body	2012.6	2342.1	994.9	804.8
Distribution (%) of est. total body accum. rate				
Head-neck	1	1	1	1
Front torso	3	2	2	2
Back torso	1	3	5	3
Arms	2	3	9	32
Upper legs	23	7	28	33
Lower legs	70	83	54	28
Air sampler ($\mu g/L$)	0.0465	0.1149	0.0409	0.1368
Tank mixture (ppm a.i.)				
As mixed	150	150	150	150
Pre-spray	44	47	115	76
Post-spray	—	39	117	74
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	0.001	0.003
Fortified pad (% rec.)	—	—	—	36
Handled pad ($\mu g/cm^2h$)	0.001	ND	0.004	0.002
Blank handwash ($\mu g/h$)	ND	ND	0.1	ND
Fortified handwash (% rec.)	—	—	—	12
Blank air sampler plug ($\mu g/L$)	ND	ND	0.0014	0.0005
Fortified air sampler plug (% rec.)	—	—	—	93
Mean temperature (°C)	27	38	34	32
Mean relative humidity (%)	78	34	67	56

(Continued)

TABLE A-9 (Continued).

	5/20/86	5/22	6/4
Exposure period (h)	0.333	0.350	0.400
Spray rate (kg a.i./h)	0.051	0.049	0.043
Flux ($\mu g/cm^2h$)			
Outside pads			
Back	0.011	0.010	0.010
Chest	0.200	0.406	0.007
Shoulders	0.016	0.014	0.010
Forearms	0.070	0.037	0.011
Thighs	0.037	0.058	0.043
Shins	0.545	0.178	0.052
Inside pads			
Chest	0.006	0.013	0.012
Forearms	0.008	0.009	0.004
Thighs	0.001	0.011	0.004
Shins	0.003	0.002	0.001
Accumulation rate ($\mu g/h$)			
Left handwash	0.7	0.9	0.4
Right handwash	11.2	1.3	0.7
Est. total body	2537.1	2112.3	367.6
Distribution (%) of est. total body accum. rate			
Head-neck	3	6	3
Front torso	23	56	6
Back torso	1	1	8
Arms	6	4	7
Upper legs	4	8	35
Lower legs	62	24	41
Air sampler ($\mu g/L$)	0.2010	0.1013	0.1505
Tank mixture (ppm a.i.)			
As mixed	225	225	180
Pre-spray	170	ND	71
Post-spray	63	ND	60
Quality assurance			
Blank pad ($\mu g/cm^2h$)	ND	0.010	ND
Fortified pad (% rec.)	97	49	42
Handled pad ($\mu g/cm^2h$)	0.002	0.001	ND
Blank handwash ($\mu g/h$)	ND	ND	ND
Fortified handwash (% rec.)	104	56	13
Blank air sampler plug ($\mu g/L$)	ND	ND	ND
Fortified air sampler plug (% rec.)	55	46	78
Mean temperature (°C)	27	31	35
Mean relative humidity (%)	70	53	56

TABLE A-10. SUBJECT MS, ETHAZOL

	2/12/86	2/26	3/19	4/7	4/15
Exposure period (h)	0.583	0.567	0.533	0.633	0.567
Spray rate (kg a.i./h)	0.029	0.030	0.032	0.027	0.015
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.008	0.004	0.003	0.001	0.001
Chest	0.013	0.014	0.005	0.003	0.003
Shoulders	0.012	0.006	0.005	0.006	0.001
Forearms	0.046	0.039	0.004	0.021	0.002
Thighs	0.035	0.214	0.015	0.082	0.012
Shins	0.251	1.442	0.044	—	0.021
Inside pads					
Chest	0.002	0.003	0.001	0.005	0.004
Forearms	0.001	0.004	0.003	0.004	0.004
Thighs	0.004	0.003	0.003	0.002	0.003
Shins	ND	0.001	ND	0.001	0.001
Accumulation rate ($\mu g/h$)					
Left handwash	0.2	1.9	0.1	0.3	0.4
Right handwash	0.2	2.5	0.2	0.3	0.6
Est. total body	1257.9	6175.0	256.8	—	140.9
Distribution (%) of est. total body accum. rate					
Head-neck	1	0	2	—	2
Front torso	4	1	6	—	7
Back torso	2	0	4	—	2
Arms	11	2	4	—	4
Upper legs	10	13	21	—	33
Lower legs	72	84	61	—	52
Air sampler ($\mu g/L$)	0.0599	0.1106	0.0147	0.0577	0.0169
Tank mixture (ppm a.i.)					
As mixed	128	150	150	150	112
Pre-spray	10	47	16	65	5
Post-spray	25	63	25	49	44
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	0.001	ND	ND
Fortified pad (% rec.)	—	69	147	43	26
Handled pad ($\mu g/cm^2h$)	0.002	ND	0.017	0.003	0.008
Blank handwash ($\mu g/h$)	ND	ND	ND	ND	ND
Fortified handwash (% rec.)	—	196	53	42	32
Blank air sampler plug ($\mu g/L$)	0.0003	0.0013	ND	0.0003	ND
Fortified air sampler plug (% rec.)	—	77	94	50	48
Mean temperature (°C)	32	33	32	28	33
Mean relative humidity (%)	43	47	68	62	53

(Continued)

TABLE A-10 (Continued).

	4/16/86	4/21	5/1	5/14	5/15
Exposure period (h)	0.500	0.617	0.500	0.550	0.467
Spray rate (kg a.i./h)	0.034	0.028	0.034	0.031	0.031
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.006	0.003	0.003	0.003	0.002
Chest	0.014	0.007	0.009	0.049	0.015
Shoulders	0.007	0.003	0.002	0.011	0.005
Forearms	0.025	0.042	0.011	0.025	0.064
Thighs	0.482	0.120	0.014	0.025	0.040
Shins	0.671	0.441	0.059	0.083	0.088
Inside pads					
Chest	0.007	0.004	0.005	0.008	0.008
Forearms	0.007	0.004	0.007	0.013	0.011
Thighs	0.005	0.004	0.005	0.009	0.004
Shins	0.002	0.001	0.001	0.004	0.003
Accumulation rate ($\mu g/h$)					
Left handwash	1.4	0.3	0.5	2.8	3.3
Right handwash	1.8	0.3	0.3	1.0	7.1
Est. total body	4364.5	2196.6	341.5	680.4	722.2
Distribution (%) of est. total body accum. rate					
Head-neck	0	0	2	4	1
Front torso	1	1	9	26	7
Back torso	0	0	3	2	1
Arms	2	5	10	11	26
Upper legs	41	20	15	14	21
Lower legs	55	72	62	44	44
Air sampler ($\mu g/L$)	0.0583	0.0322	0.0284	0.1429	0.0276
Tank mixture (ppm a.i.)					
As mixed	300	150	150	150	150
Pre-spray	5	44	4	2	31
Post-spray	124	42	48	59	60
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	0.001	ND	0.001
Fortified pad (% rec.)	22	55	42	68	31
Handled pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Blank handwash ($\mu g/h$)	0.3	ND	ND	0.1	ND
Fortified handwash (% rec.)	37	22	42	17	19
Blank air sampler plug ($\mu g/L$)	ND	0.0012	0.0004	0.0004	ND
Fortified air sampler plug (% rec.)	63	74	54	144	67
Mean temperature (°C)	25	31	33	29	29
Mean relative humidity (%)	58	60	63	58	58

TABLE A-11. SUBJECT GG, DICOFOL

	1/30/86	2/3	2/6	3/10	3/13
Exposure period (h)	1.067	0.950	0.967	0.733	0.667
Spray rate (kg a.i./h)	0.040	0.045	0.045	0.051	0.048
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.002	0.002	0.004	0.002	0.011
Chest	0.001	0.001	0.004	0.001	0.019
Shoulders	0.002	0.002	0.002	0.002	0.023
Forearms	0.004	0.023	0.005	0.004	0.024
Thighs	0.493	1.081	1.102	1.012	1.386
Shins	0.805	1.978	1.819	0.979	1.690
Inside pads					
Chest	ND	ND	ND	ND	0.002
Forearms	ND	0.001	0.001	0.002	0.004
Thighs	0.001	0.006	0.001	ND	0.003
Shins	ND	ND	ND	ND	0.001
Accumulation rate ($\mu g/h$)					
Left handwash	4.0	44.3	41.4	2.8	80.5
Right handwash	2.3	34.0	42.3	1.7	80.3
Est. total body	4994.5	11808.9	11234.7	7574.1	11922.9
Distribution (%) of est. total body accum. rate					
Head-neck	0	0	0	0	0
Front torso	0	0	0	0	0
Back torso	0	0	0	0	0
Arms	0	1	0	0	1
Upper legs	36	33	36	49	43
Lower legs	63	66	64	51	56
Air sampler ($\mu g/L$)	0.0027	0.0162	0.0066	0.0021	0.0031
Tank mixture (ppm a.i.)					
As mixed	190	190	190	199	171
Pre-spray	119	69	145	134	77
Post-spray	135	—	148	131	137
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Fortified pad (% rec.)	85	94	86	84	105
Handled pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Blank handwash ($\mu g/h$)	ND	ND	ND	ND	ND
Fortified handwash (% rec.)	83	78	76	75	82
Blank air sampler plug ($\mu g/L$)	ND	0.0013	0.0023	0.0005	ND
Fortified air sampler plug (% rec.)	85	79	71	102	98
Mean temperature (°C)	25	26	24	23	29
Mean relative humidity (%)	62	57	86	83	67

(Continued)

TABLE A-11 (Continued).

	3/18/86	4/7	4/10	4/14
Exposure period (h)	0.633	1.200	0.883	0.783
Spray rate (kg a.i./h)	0.051	0.036	0.049	0.034
Flux ($\mu g/cm^2h$)				
Outside pads	0.003	0.010	0.004	0.003
Back	0.004	0.012	0.003	ND
Chest	0.009	0.011	0.001	0.005
Shoulders	0.009	0.041	0.057	0.046
Forearms	0.942	4.026	4.928	ND
Thighs	0.888	2.556	4.002	0.018
Shins				
Inside pads	ND	ND	ND	ND
Chest	0.001	ND	0.003	ND
Forearms	0.001	0.041	0.007	ND
Thighs	0.001	ND	ND	ND
Shins				
Accumulation rate ($\mu g/h$)	4.8	2.0	1.0	2.6
Left handwash	4.0	1.9	5.1	3.1
Right handwash	6995.3	24986.2	33953.0	217.1
Est. total body				
Distribution (%) of est. total body accum. rate				
Head-neck	0	0	0	2
Front torso	0	0	0	0
Back torso	0	0	0	5
Arms	0	0	0	60
Upper legs	49	59	53	0
Lower legs	50	40	46	33
Air sampler ($\mu g/L$)	0.0032	0.0030	0.0024	0.0040
Tank mixture (ppm a.i.)				
As mixed	171	190	190	178
Pre-spray	114	146	96	61
Post-spray	120	135	77	135
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND
Fortified pad (% rec.)	96	60	111	78
Handled pad ($\mu g/cm^2h$)	ND	ND	0.001	ND
Blank handwash ($\mu g/h$)	ND	ND	ND	ND
Fortified handwash (% rec.)	71	53	100	64
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	0.0004
Fortified air sampler plug (% rec.)	47	74	142	111
Mean temperature (°C)	28	27	24	27
Mean relative humidity (%)	64	65	31	50

TABLE A-12. SUBJECT DD, FLUVALINATE

	8/22/85	9/9 A[a]	9/9 B[a]	9/27
Exposure period (h)	0.350	0.850	1.233	0.417
Spray rate (kg a.i./h)	0.023	0.046	0.032	0.038
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	0.080	ND	ND	ND
Chest	0.079	ND	ND	ND
Shoulders	0.049	ND	ND	ND
Forearms	0.070	ND	ND	ND
Thighs	0.241	0.001	0.022	0.029
Shins	4.256	0.061	0.046	0.039
Inside pads				
Chest	—	—	—	—
Forearms	—	—	—	—
Thighs	ND	0.003	0.007	0.016
Shins	ND	ND	ND	ND
Accumulation rate ($\mu g/h$)				
Left handwash	391.3	81.7	95.0	8.1
Right handwash	433.0	75.6	62.3	13.4
Est. total body	19632.8	408.3	424.2	285.0
Distribution (%) of est. total body accum. rate				
Head-neck	1	0	0	0
Front torso	1	0	0	0
Back torso	1	1	0	0
Arms	1	0	0	0
Left hand	2	20	22	3
Right hand	2	19	15	5
Upper legs	5	1	20	38
Lower legs	87	60	43	54
Air sampler ($\mu g/L$)	ND	ND	ND	0.0117
Tank mixture (ppm a.i.)				
As mixed	84	84	84	84
Pre-spray	52	63	64	71
Post-spray	54	66	75	24
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND
Fortified pad (% rec.)	155	50	22	24
Handled pad ($\mu g/cm^2h$)	—	—	—	—
Blank handwash ($\mu g/h$)	ND	ND	ND	ND
Fortified handwash (% rec.)	29	19	19	25
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	ND
Fortified air sampler plug (% rec.)	131	35	35	13
Mean temperature (°C)	29	31	27	30
Mean relative humidity (%)	78	73	83	70

[a]A and B denoted spraying at different times on the same day

(Continued)

TABLE A-12 (Continued).

	10/16/86 A	10/16 B	10/16 C
Exposure period (h)	0.550	0.717	0.500
Spray rate (kg a.i./h)	0.055	0.042	0.036
Flux ($\mu g/cm^2h$)			
Outside pads			
Back	ND	ND	ND
Chest	ND	ND	ND
Shoulders	ND	ND	ND
Forearms	ND	ND	ND
Thighs	ND	ND	ND
Shins	ND	0.039	0.286
Inside pads			
Chest	ND	—	—
Forearms	ND	—	—
Thighs	ND	ND	0.018
Shins	ND	ND	ND
Accumulation rate ($\mu g/h$)			
Left handwash	47.7	3.4	15.9
Right handwash	19.2	12.3	62.4
Est. total body	66.9	169.7	1221.8
Distribution (%) of est. total body accum. rate			
Head-neck	0	0	0
Front torso	0	0	0
Back torso	0	0	0
Arms	0	0	0
Left hand	71	2	1
Right hand	29	7	5
Upper legs	0	0	0
Lower legs	0	91	94
Air sampler ($\mu g/L$)	ND	0.0015	ND
Tank mixture (ppm a.i.)			
As mixed	80	80	80
Pre-spray	22	11	14
Post-spray	13	26	32
Quality assurance			
Blank pad ($\mu g/cm^2h$)	ND	—	—
Fortified pad (% rec.)	52	—	—
Handled pad ($\mu g/cm^2h$)	—	—	—
Blank handwash ($\mu g/h$)	ND	—	—
Fortified handwash (% rec.)	31	—	—
Blank air sampler plug ($\mu g/L$)	ND	—	—
Fortified air sampler plug (% rec.)	6	—	—
Mean temperature (°C)	28	25	25
Mean relative humidity (%)	81	87	90

TABLE A-13. SUBJECT DD, CHLORPHYRIFOS

	7/31/85	9/9 A	9/9 B	9/26 A
Exposure period (h)	0.967	0.850	1.233	0.300
Spray rate (kg a.i./h)	0.235	0.334	0.230	0.378
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	0.006	0.003	0.008	—
Chest	0.149	0.005	0.015	0.023
Shoulders	0.059	0.004	0.009	0.011
Forearms	1.660	0.011	0.016	0.091
Thighs	4.251	0.021	1.355	0.204
Shins	2.467	1.541	5.265	0.605
Inside pads				
Chest	0.008	—	—	—
Forearms	—	—	—	—
Thighs	0.001	0.012	0.016	0.014
Shins	0.002	0.006	0.010	0.004
Accumulation rate ($\mu g/h$)				
Left handwash	363.0	209.8	132.8	6938.8
Right handwash	474.5	184.2	154.2	5902.6
Est. total body	31853.8	6687.6	26465.1	—
Distribution (%) of est. total body accum. rate				
Head-neck	0	0	0	—
Front torso	2	0	0	—
Back torso	0	0	0	—
Arms	15	0	0	—
Left hand	1	3	1	—
Right hand	1	3	1	—
Upper legs	50	1	19	—
Lower legs	31	92	80	—
Air sampler ($\mu g/L$)	0.0041	0.0029	0.0080	0.0037
Tank mixture (ppm a.i.)				
As mixed	600	600	600	600
Pre-spray	295	310	723	430
Post-spray	354	243	756	404
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND
Fortified pad (% rec.)	144	96	—	69
Handled pad ($\mu g/cm^2h$)	—	—	—	—
Blank handwash ($\mu g/h$)	0.2	0.3	—	2.8
Fortified handwash (% rec.)	75	66	—	64
Blank air sampler plug ($\mu g/L$)	0.0028	ND	—	0.0079
Fortified air sampler plug (% rec.)	80	60	—	57
Mean temperature (°C)	28	31	27	28
Mean relative humidity (%)	81	73	83	92

(Continued)

TABLE A-13 (Continued).

	10/10/85	10/16 A	10/16 B	10/16 C
Exposure period (h)	0.833	0.550	0.717	0.500
Spray rate (kg a.i./h)	0.272	0.412	0.316	0.272
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	0.005	0.007	0.062	0.011
Chest	0.005	0.004	0.011	0.016
Shoulders	0.012	0.003	0.004	0.012
Forearms	0.013	0.007	0.006	0.018
Thighs	6.995	0.009	0.011	0.033
Shins	0.242	0.010	0.603	12.802
Inside pads				
Chest	—	0.012	—	—
Forearms	—	0.005	—	—
Thighs	0.024	0.014	0.030	0.054
Shins	0.001	0.003	0.001	0.003
Accumulation rate ($\mu g/h$)				
Left handwash	397.1	347.1	262.1	350.6
Right handwash	574.9	442.5	212.2	1057.5
Est. total body	27982.1	932.5	3234.4	52828.0
Distribution (%) of est. total body accum. rate				
Head-neck	0	1	1	0
Front torso	0	2	1	0
Back torso	0	3	7	0
Arms	0	2	1	0
Left hand	1	37	8	1
Right hand	2	47	7	2
Upper legs	93	4	1	0
Lower legs	3	4	74	97
Air sampler ($\mu g/L$)	0.0122	0.0057	0.0158	0.0111
Tank mixture (ppm a.i.)				
As mixed	600	600	600	600
Pre-spray	10	163	157	170
Post-spray	68	77	170	211
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND
Fortified pad (% rec.)	95	92	90	93
Handled pad ($\mu g/cm^2h$)	—	—	—	—
Blank handwash ($\mu g/h$)	0.1	ND	ND	ND
Fortified handwash (% rec.)	110	91	91	91
Blank air sampler plug ($\mu g/L$)	ND	0.0008	0.0008	0.0008
Fortified air sampler plug (% rec.)	46	80	80	90
Mean temperature (°C)	26	28	25	25
Mean relative humidity (%)	89	81	87	90

TABLE A-14. SUBJECT DD, ETHAZOL

	9/9/85 A	9/9 B
Exposure period (h)	0.850	1.233
Spray rate (kg a.i./h)	0.150	0.103
Flux ($\mu g/cm^2h$)		
Outside pads		
Back	0.005	0.007
Chest	0.011	0.033
Shoulders	0.013	0.007
Forearms	0.010	0.020
Thighs	0.018	0.096
Shins	0.131	1.306
Inside pads		
Thighs	0.015	0.020
Shins	0.005	0.003
Accumulation rate ($\mu g/h$)		
Left handwash	2.8	1.0
Right handwash	5.9	1.1
Est. total body	701.2	5794.5
Distribution (%) of est. total body accum. rate		
Head-neck	2	0
Front torso	6	2
Back torso	2	0
Arms	4	0
Left hand	0	0
Right hand	1	1
Upper legs	10	6
Lower legs	74	90
Air sampler ($\mu g/L$)	0.0343	0.1369
Tank mixture (ppm a.i.)		
As mixed	135	135
Pre-spray	109	176
Post-spray	155	147
Quality assurance		
Blank pad ($\mu g/cm^2h$)	ND	—
Fortified pad (% rec.)	65	—
Handled pad ($\mu g/cm^2h$)	—	—
Blank handwash ($\mu g/h$)	ND	—
Fortified handwash (% rec.)	42	—
Blank air sampler plug ($\mu g/L$)	ND	—
Fortified air sampler plug (% rec.)	93	—
Mean temperature (°C)	31	27
Mean relative humidity (%)	73	83

TABLE A-15. SUBJECT DD, CHLOROTHALONIL

	8/22/85	9/26 A	9/26 B
Exposure period (h)	0.350	0.300	0.567
Spray rate (kg a.i./h)	0.243	0.567	0.300
Flux ($\mu g/cm^2h$)			
Outside pads			
Back	0.134	—	0.036
Chest	0.379	0.019	0.045
Shoulders	0.456	0.194	0.069
Forearms	1.604	0.149	0.287
Thighs	3.239	0.575	7.140
Shins	25.630	1.186	13.248
Inside pads			
Thighs	0.004	0.017	0.073
Shins	0.004	0.001	0.004
Accumulation rate ($\mu g/h$)			
Left handwash	1125.0	1403.8	1251.1
Right handwash	1020.0	3629.5	1001.6
Est. total body	123499.9	—	82857.4
Distribution (%) of est. total body accum. rate			
Head-neck	0	—	0
Front torso	1	—	0
Back torso	0	—	0
Arms	4	—	1
Left hand	1	—	2
Right hand	1	—	1
Upper legs	10	—	32
Lower legs	83	—	64
Air sampler ($\mu g/L$)	0.0334	ND	0.0065
Tank mixture (ppm a.i.)			
As mixed	899	899	899
Pre-spray	1980	925	946
Post-spray	680	865	912
Quality assurance			
Blank pad ($\mu g/cm^2h$)	ND	ND	ND
Fortified pad (% rec.)	89	93	100
Handled pad ($\mu g/cm^2h$)	—	—	—
Blank handwash ($\mu g/h$)	1.0	0.7	0.8
Fortified handwash (% rec.)	27	48	—
Blank air sampler plug ($\mu g/L$)	ND	ND	0.0010
Fortified air sampler plug (% rec.)	75	59	—
Mean temperature (°C)	29	28	26
Mean relative humidity (%)	78	92	—

TABLE A-16. SUBJECT FR, FLUVALINATE

	8/12/85 A	8/12 B	8/13 A	8/13 B	8/13 C
Exposure period (h)	0.550	0.583	0.483	0.450	0.400
Spray rate (kg a.i./h)	0.115	0.109	0.130	0.141	0.158
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	ND	0.054	0.005	0.023	0.021
Chest	ND	ND	0.002	0.006	—
Shoulders	0.007	0.029	0.010	0.037	0.024
Forearms	0.064	0.027	0.030	0.053	0.023
Thighs	0.012	0.027	0.017	0.113	0.020
Shins	0.037	ND	0.006	0.019	0.014
Accumulation rate ($\mu g/h$)					
Left handwash	12.1	4.1	16.8	11.3	8.4
Right handwash	6.0	3.8	20.4	22.7	10.8
Est. total body	322.2	345.1	205.0	668.4	—
Distribution (%) of est. total body accum. rate					
Head-neck	1	10	4	5	—
Front torso	0	0	3	2	—
Back torso	0	46	7	10	—
Arms	45	18	33	18	—
Left hand	4	1	8	2	—
Right hand	2	1	10	3	—
Upper legs	11	24	25	50	—
Lower legs	37	0	10	9	—
Air sampler ($\mu g/L$)	ND	ND	ND	ND	0.0042
Tank mixture (ppm a.i.)					
As mixed	56	56	56	56	56
Pre-spray	46	33	7	26	59
Post-spray	15	36	29	59	25
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Fortified pad (% rec.)	142	62	154	167	26
Handled pad ($\mu g/cm^2h$)	—	—	—	—	—
Blank handwash ($\mu g/h$)	ND	ND	ND	0.2	ND
Fortified handwash (% rec.)	39	60	95	45	31
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	ND	ND
Fortified air sampler plug (% rec.)	55	145	56	99	78
Mean temperature (°C)	35	33	26	28	30
Mean relative humidity (%)	61	64	93	83	79

(Continued)

TABLE A-16 (Continued).

	8/13/85 D	8/13 E	8/14 A	8/14 B	8/14 C
Exposure period (h)	0.350	0.450	0.300	0.317	0.300
Spray rate (kg a.i./h)	0.181	0.141	0.105	0.100	0.105
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	ND	0.001	ND	ND	ND
Chest	ND	0.005	ND	ND	ND
Shoulders	0.003	0.006	ND	ND	ND
Forearms	0.003	0.015	ND	0.004	ND
Thighs	0.003	0.016	ND	ND	ND
Shins	0.007	0.001	ND	ND	ND
Accumulation rate ($\mu g/h$)					
Left handwash	21.4	14.4	8.2	7.1	12.4
Right handwash	4.9	48.8	4.3	9.3	11.5
Est. total body	64.5	173.8	12.5	25.5	23.9
Distribution (%) of est. total body accum. rate					
Head-neck	3	3	0	0	0
Front torso	0	9	0	0	0
Back torso	0	1	0	0	0
Arms	11	19	0	36	0
Left hand	8	8	65	28	52
Right hand	33	28	35	36	48
Upper legs	12	28	0	0	0
Lower legs	33	3	0	0	0
Air sampler ($\mu g/L$)	0.0061	ND	ND	ND	ND
Tank mixture (ppm a.i.)					
As mixed	56	56	84	84	84
Pre-spray	33	21	30	19	189
Post-spray	21	22	17	26	31
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Fortified pad (% rec.)	142	87	57	61	144
Handled pad ($\mu g/cm^2h$)	—	—	—	—	—
Blank handwash ($\mu g/h$)	0.2	0.4	ND	—	—
Fortified handwash (% rec.)	90	177	16	—	—
Blank air sampler plug ($\mu g/L$)	ND	ND	ND	—	—
Fortified air sampler plug (% rec.)	39	78	60	—	—
Mean temperature (°C)	28	26	25	28	31
Mean relative humidity (%)	78	86	94	83	74

TABLE A-17. SUBJECT FR, CHLORPYRIFOS

	8/7/85	8/8 A	8/8 B	8/9	8/12 A
Exposure period (h)	0.500	0.500	0.517	0.500	0.550
Spray rate (kg a.i./h)	0.907	0.907	0.878	0.907	0.825
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.062	0.135	0.104	0.243	0.062
Chest	0.013	0.048	0.033	0.090	0.015
Shoulders	0.049	0.197	0.249	0.445	0.174
Forearms	0.055	0.220	0.241	2.405	0.101
Thighs	0.181	1.220	0.385	0.660	0.038
Shins	0.098	0.964	0.127	0.356	0.810
Accumulation rate ($\mu g/h$)					
Left handwash	224.5	251.0	78.2	168.4	22.3
Right handwash	286.4	496.5	190.0	336.1	588.4
Est. total body	1760.3	8700.4	2973.3	10467.6	3921.9
Distribution (%) of est. total body accum. rate					
Head-neck	3	2	7	4	3
Front torso	2	2	3	2	1
Back torso	10	5	10	7	5
Arms	7	6	18	53	6
Left hand	13	3	3	2	1
Right hand	16	6	6	3	15
Upper legs	31	42	39	19	3
Lower legs	18	36	14	11	66
Air sampler ($\mu g/L$)	0.0077	0.0218	0.0114	0.0149	0.0147
Tank mixture (ppm a.i.)					
As mixed	400	400	400	400	400
Pre-spray	290	73	163	266	224
Post-spray	298	134	232	288	268
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	0.018	0.001	0.004	ND
Fortified pad (% rec.)	75	50	67	72	101
Handled pad ($\mu g/cm^2h$)	—	—	—	—	—
Blank handwash ($\mu g/h$)	0.1	0.9	—	0.5	0.2
Fortified handwash (% rec.)	75	78	—	64	110
Blank air sampler plug ($\mu g/L$)	0.0015	0.0109	—	0.0016	0.0052
Fortified air sampler plug (% rec.)	75	55	—	47	83
Mean temperature (°C)	27	28	30	27	35
Mean relative humidity (%)	85	83	70	85	61

(Continued)

TABLE A-17 (Continued).

	8/12/85 B	8/13 A	8/13 B	8/13 C	8/13 D
Exposure period (h)	0.583	0.483	0.450	0.400	0.350
Spray rate (kg a.i./h)	0.778	0.938	1.008	1.134	1.296
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.068	0.058	0.109	0.248	0.023
Chest	0.156	0.043	0.101	—	0.013
Shoulders	0.101	0.186	0.548	0.364	0.078
Forearms	0.054	0.175	0.443	0.472	0.063
Thighs	0.056	0.369	1.378	0.711	0.048
Shins	0.033	0.111	0.256	0.273	0.027
Accumulation rate ($\mu g/h$)					
Left handwash	37.2	469.3	177.7	857.2	476.3
Right handwash	179.7	368.4	529.6	447.5	112.4
Est. total body	2890.9	3138.7	7674.7	—	1124.0
Distribution (%) of est. total body accum. rate					
Head-neck	5	5	5	—	5
Front torso	16	4	4	—	3
Back torso	7	5	4	—	6
Arms	4	13	13	—	13
Left hand	1	15	2	—	42
Right hand	6	12	7	—	10
Upper legs	57	35	54	—	13
Lower legs	4	11	11	—	8
Air sampler ($\mu g/L$)	0.0232	0.0321	0.0551	0.0682	0.0225
Tank mixture (ppm a.i.)					
As mixed	400	400	400	400	400
Pre-spray	196	157	204	179	34
Post-spray	155	24	247	170	205
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Fortified pad (% rec.)	63	40	74	90	81
Handled pad ($\mu g/cm^2h$)	—	—	—	—	—
Blank handwash ($\mu g/h$)	—	ND	—	—	ND
Fortified handwash (% rec.)	—	95	—	—	2
Blank air sampler plug ($\mu g/L$)	—	0.0058	—	—	ND
Fortified air sampler plug (% rec.)	—	27	—	—	80
Mean temperature (°C)	33	26	28	30	28
Mean relative humidity (%)	64	93	83	79	78

(Continued)

TABLE A-17 (Continued).

	8/13/85 E	8/14 A	8/14 B	8/14 C
Exposure period (h)	0.450	0.300	0.317	0.300
Spray rate (kg a.i./h)	1.008	0.756	0.716	0.756
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	0.060	0.028	0.011	0.015
Chest	0.111	0.007	0.011	0.017
Shoulders	0.167	0.008	0.012	0.016
Forearms	0.197	0.010	0.010	0.013
Thighs	0.253	0.012	0.009	0.016
Shins	0.036	0.010	0.012	0.012
Accumulation rate ($\mu g/h$)				
Left handwash	61.8	152.5	317.1	218.7
Right handwash	116.5	702.5	117.9	67.3
Est. total body	2099.5	1066.9	602.8	514.8
Distribution (%) of est. total body accum. rate				
Head-neck	9	2	2	4
Front torso	11	2	5	10
Back torso	8	8	5	8
Arms	21	2	4	6
Left hand	3	14	53	42
Right hand	6	66	20	13
Upper legs	36	3	5	9
Lower legs	6	3	6	7
Air sampler ($\mu g/L$)	0.0269	0.0070	0.0076	0.0099
Tank mixture (ppm a.i.)				
As mixed	400	600	600	600
Pre-spray	177	485	617	951
Post-spray	188	143	276	623
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	0.007	ND	ND
Fortified pad (% rec.)	100	85	129	82
Handled pad ($\mu g/cm^2h$)	—	—	—	—
Blank handwash ($\mu g/h$)	—	ND	—	—
Fortified handwash (% rec.)	—	75	—	—
Blank air sampler plug ($\mu g/L$)	—	ND	—	—
Fortified air sampler plug (% rec.)	—	145	—	—
Mean temperature (°C)	26	25	28	31
Mean relative humidity (%)	86	94	83	74

TABLE A-18. SUBJECT FR, CAPTAN

	8/12/85 A	8/12 B	8/13 A	8/13 B	8/13 C
Exposure period (h)	0.550	0.583	0.483	0.450	0.400
Spray rate (kg a.i./h)	0.824	0.777	0.938	1.007	1.133
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.011	0.057	0.066	0.108	0.215
Chest	0.011	0.007	0.464	0.097	—
Shoulders	0.158	0.091	0.212	0.550	0.360
Forearms	0.068	0.039	0.221	0.401	0.552
Thighs	0.039	0.050	0.403	1.324	0.752
Shins	0.559	0.012	0.121	0.317	0.313
Accumulation rate ($\mu g/h$)					
Left handwash	3.2	6.7	39.5	187.0	120.4
Right handwash	65.6	23.5	241.5	45.4	255.4
Est. total body	2306.7	570.1	4219.8	7125.0	—
Distribution (%) of est. total body accum. rate					
Head-neck	5	14	7	6	—
Front torso	1	4	32	4	—
Back torso	1	29	5	4	—
Arms	7	16	12	13	—
Left hand	0	1	1	3	—
Right hand	3	4	6	1	—
Upper legs	5	26	28	55	—
Lower legs	78	7	9	14	—
Air sampler ($\mu g/L$)	0.0011	0.0067	0.0192	0.0311	0.0292
Tank mixture (ppm a.i.)					
As mixed	400	400	400	400	400
Pre-spray	244	202	73	129	73
Post-spray	290	216	19	150	98
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Fortified pad (% rec.)	47	9	74	71	105
Handled pad ($\mu g/cm^2h$)	—	—	—	—	—
Blank handwash ($\mu g/h$)	ND	—	ND	—	—
Fortified handwash (% rec.)	16	—	7	—	—
Blank air sampler plug ($\mu g/L$)	ND	—	ND	—	—
Fortified air sampler plug (% rec.)	80	—	92	—	—
Mean temperature (°C)	35	33	26	28	30
Mean relative humidity (%)	61	64	93	83	79

(Continued)

TABLE A-18 (Continued).

	8/13/85 D	8/13 E	8/14 A	8/14 B	8/14 C
Exposure period (h)	0.350	0.450	0.300	0.317	0.300
Spray rate (kg a.i./h)	1.295	1.007	0.756	0.716	0.756
Flux ($\mu g/cm^2h$)					
Outside pads					
Back	0.008	0.029	ND	ND	0.032
Chest	0.006	0.089	0.032	0.013	ND
Shoulders	0.067	0.169	0.017	0.005	0.008
Forearms	0.090	0.148	0.017	0.003	ND
Thighs	0.051	0.178	0.019	0.003	0.015
Shins	0.014	0.021	0.019	ND	ND
Accumulation rate ($\mu g/h$)					
Left handwash	260.1	49.6	50.8	35.4	43.4
Right handwash	237.6	44.4	111.0	25.8	15.2
Est. total body	984.8	1517.8	435.6	121.4	211.8
Distribution (%) of est. total body accum. rate					
Head-neck	5	10	5	6	7
Front torso	2	17	22	31	0
Back torso	2	6	0	0	44
Arms	21	22	9	6	0
Left hand	26	3	12	29	20
Right hand	24	3	25	21	7
Upper legs	15	35	13	7	21
Lower legs	4	4	14	0	0
Air sampler ($\mu g/L$)	0.0053	0.0094	0.0078	0.0104	ND
Tank mixture (ppm a.i.)					
As mixed	400	400	600	600	600
Pre-spray	22	97	483	560	598
Post-spray	106	142	224	260	706
Quality assurance					
Blank pad ($\mu g/cm^2h$)	ND	ND	ND	ND	ND
Fortified pad (% rec.)	65	68	43	71	60
Handled pad ($\mu g/cm^2h$)	—	—	—	—	—
Blank handwash ($\mu g/h$)	ND	—	ND	—	—
Fortified handwash (% rec.)	14	—	15	—	—
Blank air sampler plug ($\mu g/L$)	ND	—	ND	—	—
Fortified air sampler plug (% rec.)	47	—	34	—	—
Mean temperature (°C)	28	26	25	28	31
Mean relative humidity (%)	78	86	94	83	74

TABLE A-19. SUBJECT FR, CHLOROTHALONIL

	8/7/85	8/8 A	8/8 B	8/9
Exposure period (h)	0.500	0.500	0.517	0.500
Spray rate (kg a.i./h)	1.361	1.361	1.317	1.361
Flux ($\mu g/cm^2h$)				
Outside pads				
Back	0.079	0.232	0.164	0.392
Chest	0.008	0.031	0.024	0.123
Shoulders	0.079	0.554	0.305	0.880
Forearms	0.084	0.442	0.310	0.676
Thighs	0.263	0.663	0.854	0.802
Shins	0.182	0.164	0.234	0.276
Accumulation rate ($\mu g/h$)				
Left handwash	183.9	175.8	214.3	263.1
Right handwash	127.3	471.3	256.7	505.4
Est. total body	2206.0	5361.0	5275.2	7811.0
Distribution (%) of est. total body accum. rate				
Head-neck	4	8	5	9
Front torso	1	2	1	5
Back torso	10	13	9	15
Arms	9	19	13	20
Left hand	8	3	4	3
Right hand	6	9	5	6
Upper legs	36	37	48	31
Lower legs	26	10	14	11
Air sampler ($\mu g/L$)	0.0054	0.0124	0.0088	0.0107
Tank mixture (ppm a.i.)				
As mixed	600	600	600	600
Pre-spray	683	680	523	645
Post-spray	700	581	642	699
Quality assurance				
Blank pad ($\mu g/cm^2h$)	ND	ND	—	0.001
Fortified pad (% rec.)	—	—	—	—
Handled pad ($\mu g/cm^2h$)	—	—	—	—
Blank handwash ($\mu g/h$)	0.1	0.3	—	ND
Fortified handwash (% rec.)	—	—	—	1
Blank air sampler plug ($\mu g/L$)	0.0009	0.0020	—	—
Fortified air sampler plug (% rec.)	—	—	—	—
Mean temperature (°C)	27	28	30	27
Mean relative humidity (%)	85	83	70	85

TABLE A-20. SUBJECT DP, CHLORPYRIFOS

	7/23/85
Exposure period (h)	0.167
Spray rate (kg a.i./h)	0.213
Flux (µg/cm^2 h)	
Outside pads	
Back	0.002
Chest	0.007
Shoulders	0.023
Forearms	0.010
Thighs	2.593
Shins	0.380
Inside pads	
Chest	0.009
Forearms	0.016
Thighs	0.020
Shins	0.003
Accumulation rate (µg/h)	
Left handwash	82.1
Right handwash	34.2
Est. total body	9422.7
Distribution (%) of est. total body accum. rate	
Head-neck	0
Front torso	0
Back torso	0
Arms	0
Upper legs	87
Lower legs	12
Air sampler (µg/L)	ND
Tank mixture (ppm a.i.)	
As mixed	468
Pre-spray	119
Post-spray	183
Quality assurance	
Blank pad (µg/cm^2 h)	ND
Fortified pad (% rec.)	61
Handled pad (µg/cm^2 h)	--
Blank handwash (µg/h)	ND
Fortified handwash (% rec.)	69
Blank air sampler plug (µg/L)	ND
Fortified air sampler plug (% rec.)	70
Mean temperature (°C)	30
Mean relative humidity (%)	76

APPENDIX B. QUALITY ASSURANCE

FORTIFICATIONS AND BLANKS

Each day samplers went to the field to collect exposure data from a subject, the following quality assurance materials were taken along to the field, one set for each compound which was to be applied: two blank pads and one fortified (10 µg) pad, each wrapped in aluminum foil; one blank and one fortified (10 µg) handwash, i.e., a pint Mason™ jar containing a Baggie™ tied at the top which itself contained 200 mL of 95% ethanol; and one blank and one fortified (10 µg) air sampler plug, each wrapped in aluminum foil. The extra blank pad served as the "handled" pad. These quality assurance materials were stored with the subject's set for that day, then extracted and analyzed along with the subject's set. Mean percent recoveries from fortified pads, handwashes, and air sampler plugs over the entire course of the study are presented in TABLE B-1. The individual daily values appear in Appendix A. With very few exceptions, extractions of blank pads, "handled" blank pads, blank handwashes, and blank air sampler plugs gave nondetectable levels of compound (Appendix A). If a quantifiable level was detected, it was reported in Appendix A in the same units as the corresponding exposed substrate. This normalization process allows for easier comparison between the contaminated blank and the exposed pad, handwash, or plug.

LOSS OF COMPOUND DURING STORAGE

Losses of compound before chromatographic analysis can arise in three ways. First, loss can take place from the collection pad itself while the subject is wearing the pad, a time interval in this study of usually less than one hour. To test this possibility, 28 exposure pads were each fortified with 10 µg of one kind of compound. They were suspended vertically from a horizontal rope in a certain type of greenhouse: an enclosed structure, an open sided structure, or an open structure. Four pads were collected randomly at 0, 10, 20, 30, 40, 50 and 60 minutes post-fortification. Immediately after collection, the pads were wrapped in aluminum foil, placed on ice, transported to the laboratory, and analyzed. The results of these experiments for each compound appear in TABLE B-2. A linear regression analysis was performed on the mean pad recoveries over the 60 minute collection period. In some cases, the regression line slope was zero (loss = 0); that is, the statistical hypothesis "slope = 0" could not be rejected at the 95% confidence level. For the remaining experiments, the slope is given in µg of compound lost per minute. What was observed was an occasional statistical gain in compound (negative loss), amounting in the worst case to a gain of 3.6 µg (36%) over the 60 minute collection period for fluvalinate in an enclosed greenhouse. We attribute these apparent gains in compound to random errors in fortifying

the pads, extraction, and analysis. These experiments certainly confirmed no loss of compound from pads worn by subjects.

A second mechanism for loss occurred when the pads awaited extraction, either on ice during transportation to the laboratory or in the laboratory freezer. Pads were usually extracted the day following collection in the field. However, on certain occasions, pad storage in the laboratory extended over several days. To assess loss of compound from pads stored in the laboratory, an experiment was done using methods identical to the above except that pads were fortified in the laboratory, stored in the laboratory freezer, and extracted on days 1, 2, 3, 6, 7, 8, 13 post-fortification. If a given compound, say ethazol, had been stored on pads for no longer than 6 days, the experiment ceased for that compound on day 6 post-fortification. The results of this test are given in TABLE B-3. Once again, two of the compounds, dicofol and chlorothalonil, showed a slight but statistically significant gain.

The third possibility for storage loss occurred during the interval between extraction and chromatographic analysis, when compounds were stored in vials containing 10 mL of hexane solvent in the laboratory freezer. This loss was assessed for each compound by adding 15 µg of compound to each of 20 vials, placing the vials in the freezer, and analyzing the contents of all 20 vials at intervals of several days. The experiment for each chemical extended over a period no less than the longest period the given chemical had been so stored. The results appear in TABLE B-4. A slight loss of compound was statistically identified for ethazol in the amount of 0.023 µg/day or 0.15%/day. Dicofol showed no loss through day 20 of storage, but declined to 9.1 $\pm$ 0.1 ug on day 52, the final testing day. All other compounds were negative for storage loss in vials.

RANDOM REANALYSIS

A final quality assurance test consisted of a reanalysis by chromotagraphy of 10% of the total of all samples analyzed in the entire study. This 10% subset of samples was selected using a table of random numbers and consisted of 276 samples. The results comprise TABLE B-5. The data of TABLE B-5 are difficult to summarize: calculating percent differences between the original and reanalyzed values greatly exaggerates differences between small values, and non-detectable levels cannot be handled this way at all. We have elected, therefore, to report a summary of D = [reanalysis value minus original value]. The frequency of D's falling into various intervals is displayed with a bar graph in FIGURE B-1. Sixty percent (166/276) of all samples reanalyzed were within 1 µg of the original measurement. Another twenty-three percent (63/276) were within 1-10 µg of the original measurement. The remaining seventeen percent nearly always involved samples containing large amounts of compound.

Approximately one year elapsed between the times the original and reanalyzed values were measured (TABLE B-5). What effect this might have had on the D's is problematic. We have now altered our procedures to reanalyze concurrently this random subset.

TABLE B-1. MEAN[a] RECOVERIES (%) FROM 10 µg FORTIFICATIONS, ALL SUBJECTS

Compound	Pads	Handwashes	Air sampler Plugs
Fluvalinate	75 ± 6 (49)	62 ± 6 (47)	51 ± 4 (46)
Chlorpyrifos	82 ± 3 (49)	79 ± 4 (42)	73 ± 4 (42)
Ethazol	51 ± 7 (19)	45 ± 10 (19)	68 ± 8 (19)
Dicofol	89 ± 5 (9)	76 ± 4 (9)	90 ± 9 (9)
Captan	61 ± 8 (10)	13 ± 2 (4)	63 ± 14 (4)
Chlorothalonil	94 ± 3 (3)	25 ± 14 (3)	67 ± 8 (2)

[a] ± standard error (number of replications)

TABLE B-2. LOSS[a] OF COMPOUND (µg/min) FROM PADS FORTIFIED IN THE FIELD WITH 10 µg

Compound	Enclosed structure	Open sided structure	Open structure
Fluvalinate	-0.065 ± 0.009[b]	-0.051 ± 0.013	--
Chlorpyrifos	-0.030 ± 0.010	-0.019 ± 0.007	loss = 0
Ethazol	loss = 0	--	--
Dicofol	-0.022 ± 0.006	--	--
Captan	--	--	loss = 0
Chlorothalonil	--	loss = 0	--

[a] negative losses are gains

[b] linear regression line slope ± standard error

TABLE B-3. LOSS[a] OF COMPOUND (µg/day) FROM PADS FORTIFIED IN THE LABORATORY WITH 10 µg

Compound	Loss (µg/day)	Maximum storage time (day)	Analyzed (days post-fortification)
Fluvalinate	loss = 0	13	1, 2, 3, 6, 7, 8, 13
Chlorpyrifos	loss = 0	13	1, 2, 3, 6, 7, 13
Ethazol	loss = 0	6	1, 2, 3, 6
Dicofol	-0.259 ± 0.007[b]	7	1, 2, 3, 6, 7
Captan	loss = 0	8	1, 2, 3, 6, 7, 8
Chlorothalonil	-0.087 ± 0.014	13	1, 2, 3, 6, 7, 13

[a]negative losses are gains

[b]linear regression line slope ± standard error

TABLE B-4. LOSS[a] OF COMPOUND (µg/day) FROM VIALS FORTIFIED IN THE LABORATORY WITH 15 µg

Compound	Loss (µg/day)	Maximum storage time (days)	Analyzed (days post-fortification)
Fluvalinate	loss = 0	98	0, 7, 20, 51, 98
Chlorpyrifos	loss = 0	105	0, 8, 20, 49, 96, 105
Ethazol	0.023 ± 0.002[b]	91	0, 6, 20, 49, 91
Dicofol	loss = 0, thru day 20	28	0, 6, 20, 52
Captan	loss = 0	56	0, 13, 34, 62
Chlorothalonil	loss = 0	105	0, 6, 20, 48, 90, 105

[a]negative losses are gains

[b]linear regression line slope ± standard error

TABLE B-5. COMPARISON OF CHROMATOGRAPH REANALYSIS WITH ORIGINAL VALUES

Sample code			
P - OB	outside back pad	P - H	handled blank pad
P - OC	outside chest pad	P - FO	fortified pad
P - OS	outside shoulder pads	H - L	left handvash
P - OF	outside forearm pads	H - R	right handvash
P - OT	outside thigh pads	H - B	blank handvash
P - OSN	outside shin pads	H - FO	fortified handvash
P - IC	inside chest pad	A	air sampler plug
P - IF	inside forearm pads	A - B	blank air sampler plug
P - IT	inside thigh pads	A - FO	fortified air sampler plug
P - ISN	inside shin pads	T - PR	pre-spray tank mixture
P - B	blank pad	T - PO	post-spray tank mixture

Date sample collected	Subject	Sample code	Date of analysis	Date of reanalysis	Original value (µg)	Reanalysis value (µg)
			FLUVALINATE			
7-25-85	VG	P - ISN	8-6-85	9-5-86	0.56	1.40
7-25-85	VG	P - OF	8-6-85	9-18-86	0.47	1.44
8-28-85	VG	P - IF	10-11-85	9-18-86	0.15	ND
8-28-85	VG	P - OF	10-11-85	9-5-86	6.36	22.54
8-28-85	VG	H - L	10-11-85	9-19-86	7.89	3.78
8-28-85	VG	T - PO	11-25-85	9-16-86	67.00	108.43
3-27-86	VG	P - IC	6-3-86	9-5-86	ND	ND
3-27-86	VG	P - ISN	6-3-86	9-5-86	ND	ND
5-19-86	VG	P - FO	6-20-86	9-9-86	6.53	9.00
5-19-86	VG	P - OSN	6-20-86	9-18-86	7.82	9.37
11-14-85	KM	P - OSN	11-20-85	9-18-86	4.75	7.26
11-14-85	KM	P - OT	11-20-85	9-5-86	0.44	ND
11-14-85	KM	T - PR	11-27-85	9-16-86	55.72	83.49
11-27-85	KM	P - OSN	12-9-85	9-9-86	63.79	228.02
11-27-85	KM	A	12-9-85	9-19-86	1.76	0.31
3-12-86	KM	P - OB	5-27-86	9-5-86	4.17	2.17
3-12-86	KM	P - IF	5-27-86	9-18-86	0.21	ND

(Continued)

TABLE B-5 (Continued).

Date sample collected	Subject	Sample code	Date of analysis	Date of reanalysis	Original value (µg)	Reanalysis value (µg)
3-12-86	KM	H - L	5-27-86	9-19-86	4.55	2.65
3-26-86	KM	P - IC	6-2-86	9-9-86	ND	ND
3-26-86	KM	P - IF	6-2-86	9-5-86	ND	ND
3-26-86	KM	P - OF	6-2-86	9-9-86	9.55	4.40
3-26-86	KM	A - FO	6-2-86	9-19-86	3.63	4.98
3-26-86	KM	H - FO	6-2-86	9-22-86	4.23	ND
4-2-86	KM	P - OC	6-9-86	9-9-86	1.32	1.36
4-10-86	KM	P - OS	6-20-86	9-18-86	0.18	ND
4-10-86	KM	H - FO	6-20-86	9-22-86	1.13	1.80
5-6-86	KM	A	7-3-86	9-19-86	0.21	0.24
5-6-86	KM	P - FO	7-3-86	9-5-86	7.89	7.09
5-6-86	KM	P - OT	7-3-86	9-5-86	31.53	40.15
5-8-86	KM	P - IT	7-7-86	9-9-86	ND	ND
5-8-86	KM	P - B	7-7-86	9-5-86	ND	ND
5-8-86	KM	P - IF	7-7-86	9-5-86	ND	ND
5-8-86	KM	T - PO	7-7-86	9-16-86	66.98	94.11
6-4-86	KM	P - OF	8-6-86	9-18-86	1.32	0.71
6-4-86	KM	P - OS	8-6-86	9-5-86	1.31	0.50
8-1-85	MS	P - B	8-14-85	9-18-86	0.02	ND
8-1-85	MS	P - OSN	8-14-85	9-9-86	28.84	48.15
8-1-85	MS	P - OT	8-14-85	9-9-86	18.66	25.96
9-10-85	MS	P - B	10-22-85	9-18-86	ND	ND
9-10-85	MS	P - OB	10-22-85	9-5-86	ND	ND
9-10-85	MS	A	10-22-85	9-19-86	0.29	1.04
10-30-85	MS	P - B	11-13-85	9-18-86	ND	ND
4-9-86	MS	P - ISN	6-13-86	9-5-86	ND	ND
2-12-86	MS	P - IT	5-14-86	9-9-86	0.07	ND
2-12-86	MS	P - OT	5-14-86	9-5-86	77.02	57.58
2-12-86	MS	A - B	5-14-86	9-19-86	ND	ND
2-26-86	MS	H - FO	5-23-86	9-19-86	10.78	13.94
4-1-86	MS	P - B	6-5-86	9-5-86	ND	ND
4-9-86	MS	P - H	6-13-86	9-18-86	ND	ND
4-9-86	MS	H - FO	6-13-86	9-19-86	7.59	11.70
5-15-86	MS	P - OF	6-24-86	9-18-86	83.66	94.15
5-15-86	MS	P - FO	6-24-86	9-9-86	6.69	6.75
5-15-86	MS	P - OSN	6-24-86	9-9-86	53.56	54.79
5-27-86	MS	P - B	7-14-86	9-5-86	ND	ND
5-27-86	MS	P - IF	7-14-86	9-9-86	ND	0.08
5-27-86	MS	P - OF	7-14-86	9-5-86	40.25	16.78
5-27-86	MS	H - B	7-14-86	9-19-86	ND	ND
3-25-86	GG	P - IC	5-28-86	9-9-86	ND	ND
3-25-86	GG	P - OF	5-28-86	9-5-86	10.34	8.70
3-25-86	GG	P - OSN	5-28-86	9-5-86	385.58	309.31

(Continued)

TABLE B-5 (Continued).

Date sample collected	Subject	Sample code	Date of analysis	Date of reanalysis	Original value (µg)	Reanalysis value (µg)
3-31-86	GG	P - OB	6-4-86	9-5-86	0.99	0.70
3-31-86	GG	P - IF	6-4-86	9-18-86	0.50	0.40
3-31-86	GG	A - B	6-4-86	9-19-86	ND	ND
4-1-86	GG	P - IF	6-6-86	9-5-86	0.10	ND
4-4-86	GG	P - IF	6-12-86	9-18-86	0.11	0.04
4-4-86	GG	P - IC	6-12-86	9-18-86	ND	ND
4-4-86	GG	T - PO	6-12-86	9-16-86	106.91	257.73
4-22-86	GG	P - OT	6-30-86	9-18-86	7.56	2.90
4-22-86	GG	P - FO	6-30-86	9-18-86	6.71	9.82
4-22-86	GG	A	6-30-86	9-19-86	9.23	9.23
4-22-86	GG	T - PR	6-30-86	9-16-86	281.17	ND
5-20-86	GG	P - FO	7-10-86	9-5-86	11.36	4.64
5-20-86	GG	P - OC	7-10-86	9-5-86	0.61	ND
5-20-86	GG	H - L	7-10-86	9-19-86	1.55	6.78
5-22-86	GG	P - B	7-11-86	9-5-86	ND	ND
5-22-86	GG	P - IC	7-11-86	9-9-86	ND	ND
5-22-86	GG	A - B	7-11-86	9-19-86	ND	ND
5-22-86	GG	H - FO	7-11-86	9-22-86	14.42	11.82
8-22-85	DD	P - ISN	10-7-85	9-9-86	ND	ND
8-22-85	DD	P - OS	10-7-85	9-5-86	1.39	0.66
9-9-85 (A)	DD	P - OSN	10-15-85	9-9-86	4.18	31.20
9-27-85	DD	P - OS	10-25-85	9-9-86	ND	ND
9-27-85	DD	H - R	10-25-85	9-19-86	5.57	1115.75
9-27-85	DD	H - FO	10-25-85	9-22-86	2.51	7.88
10-16-85 (A)	DD	P - IC	11-4-85	9-5-86	ND	ND
10-16-85 (A)	DD	P - OB	11-4-85	9-5-86	ND	ND
10-16-85 (B)	DD	P - OT	11-5-85	9-5-86	ND	0.13
10-16-85 (B)	DD	H - L	11-6-85	9-22-86	2.45	55.62
10-16-85 (C)	DD	P - B	11-6-85	9-5-86	ND	ND
10-16-85 (C)	DD	P - OC	11-7-85	9-5-86	ND	ND
8-12-85 (A)	FR	P - OB	8-29-85	9-5-86	ND	ND
8-12-85 (B)	FR	P - OC	8-30-85	9-5-86	ND	ND
8-13-85 (A)	FR	P - B	9-6-85	9-5-86	ND	ND
8-13-85 (A)	FR	P - OC	9-6-85	9-5-86	0.04	0.15
8-13-85 (B)	FR	P - OT	9-13-85	9-18-86	4.09	6.10
8-13-85 (B)	FR	P - OS	9-13-85	9-9-86	1.34	2.72
8-13-85 (B)	FR	P - OF	9-13-85	9-5-86	1.91	3.04
8-13-85 (B)	FR	H - FO	9-13-85	9-19-86	4.54	23.64
8-13-85 (C)	FR	P - FO	9-18-85	9-5-86	2.56	12.87
8-13-85 (E)	FR	P - OC	9-19-85	9-5-86	0.10	0.24
8-14-85 (A)	FR	A - FO	9-27-85	9-16-86	6.00	16.78
8-14-85 (B)	FR	P - B	9-27-85	9-18-86	ND	ND

(Continued)

TABLE B-5 (Continued).

Date sample collected	Subject	Sample code	Date of analysis	Date of reanalysis	Original value (µg)	Reanalysis value (µg)
			CHLORPYRIFOS			
7-23-85	VG	P - IT	7-30-85	9-4-86	0.05	ND
7-23-85	VG	A	7-30-85	9-5-86	0.22	4.57
7-30-85	VG	P - OC	8-20-85	9-4-86	0.98	5.51
7-30-85	VG	P - OS	8-20-85	9-4-86	0.82	4.55
8-22-85	VG	P - OC	9-17-85	9-4-86	1.96	13.29
8-22-85	VG	P - IC	9-17-85	9-4-86	0.17	1.01
10-10-85	VG	P - OB	10-14-85	9-5-86	0.78	0.14
11-5-85	VG	P - IC	11-7-85	9-5-86	0.01	ND
11-5-85	VG	P - OB	11-7-85	9-5-86	0.07	0.23
11-5-85	VG	H - R	11-12-85	9-9-86	1.82	3.46
11-7-85	VG	A - FO	11-12-85	9-9-86	8.93	28.09
12-2-85	VG	P - IF	12-9-85	9-4-86	1.23	8.92
12-2-85	VG	P - OC	12-9-85	9-4-86	0.59	4.64
12-2-85	VG	P - OB	12-9-85	9-5-86	0.20	0.28
12-2-85	VG	P - OSN	12-9-85	9-8-86	42.61	170.40
12-5-85	VG	P - OC	12-14-85	9-4-86	0.80	1.65
12-5-85	VG	P - IT	12-14-85	9-4-86	ND	0.54
12-5-85	VG	A - B	12-14-85	9-9-86	ND	0.20
4-23-86	VG	P - IT	5-5-86	9-4-86	14.58	62.76
4-28-86	VG	P - IC	5-6-86	9-4-86	0.06	ND
4-29-86	VG	P - OB	5-7-86	9-5-86	0.25	0.18
4-29-86	VG	P - IC	5-7-86	9-5-86	0.30	0.24
4-29-86	VG	P - OSN	5-7-86	9-9-86	1.19	1.25
4-29-86	VG	T - PO	5-7-86	9-11-86	184.08	245.90
4-23-86	VG	H - B	5-5-86	9-5-86	ND	0.19
12-10-85	KM	P - B	12-18-85	9-4-86	ND	ND
12-10-85	KM	P - OF	12-18-85	9-5-86	0.63	1.49
12-10-85	KM	P - IT	12-18-85	9-4-86	0.49	1.07
12-11-85	KM	P - FO	12-23-85	9-5-86	9.33	8.87
12-11-85	KM	P - OC	12-23-85	9-5-86	0.06	0.09
12-11-85	KM	P - OSN	12-23-85	9-9-86	1.64	4.13
12-11-85	KM	H - B	12-23-85	9-5-86	ND	0.07
1-23-86	KM	P - B	2-13-86	9-4-86	ND	ND
1-23-86	KM	P - IT	2-12-86	9-4-86	0.08	0.35
1-23-86	KM	P - IC	2-12-86	9-4-86	ND	0.59
2-25-86	KM	A - FO	3-11-86	9-9-86	5.50	6.25
3-5-86	KM	H - B	3-17-86	9-5-86	ND	0.06
3-5-86	KM	H - FO	3-17-86	9-8-86	11.02	10.75
5-9-86	KM	P - IF	5-19-86	9-4-86	0.12	0.45
5-9-86	KM	P - OF	5-19-86	9-4-86	8.55	50.08
5-9-86	KM	H - R	5-20-86	9-9-86	5.27	5.71

(Continued)

TABLE B-5 (Continued).

Date sample collected	Subject	Sample code	Date of analysis	Date of reanalysis	Original value (µg)	Reanalysis value (µg)
5-20-86	KM	P - H	6-27-86	9-4-86	ND	ND
8-13-85	MS	P - ISN	9-3-85	9-4-86	0.05	0.41
8-13-85	MS	P - IT	9-3-85	9-5-86	0.10	0.11
9-17-85	MS	P - OB	9-20-85	9-4-86	0.13	0.84
9-17-85	MS	A - B	9-20-85	9-5-86	ND	0.55
9-17-85	MS	H - R	9-20-85	9-9-86	7.20	2.31
10-24-85	MS	P - OF	10-28-85	9-5-86	97.82	19.63
12-3-85	MS	P - IT	12-17-85	9-4-86	ND	ND
12-3-85	MS	P - OS	12-17-85	9-5-86	1.13	1.23
12-3-85	MS	H - L	12-18-85	9-9-86	15.07	23.29
1-23-86	MS	P - IF	2-17-86	9-5-86	0.13	0.08
1-23-86	MS	P - OB	2-17-86	9-5-86	0.19	0.17
1-28-86	MS	P - IT	2-19-86	9-4-86	ND	ND
1-28-86	MS	A	2-19-86	9-9-86	ND	0.28
1-28-86	MS	A - B	2-19-86	9-9-86	ND	ND
4-15-86	MS	P - OC	5-2-86	9-4-86	1.31	7.36
4-15-86	MS	P - OSN	5-2-86	9-8-86	192.31	165.11
4-15-86	MS	T - PO	5-7-86	9-11-86	42.19	5.62
4-16-86	MS	P - IC	5-1-86	9-5-86	0.04	ND
4-16-86	MS	P - IF	5-1-86	9-5-86	0.17	0.16
4-16-86	MS	P - OT	5-1-86	9-5-86	144.73	160.35
4-16-86	MS	H - FO	5-1-86	9-5-86	7.62	9.22
4-16-86	MS	P - OSN	5-1-86	9-8-86	100.50	100.22
4-16-86	MS	H - B	5-1-86	9-9-86	0.12	0.07
5-14-86	MS	P - IC	5-20-86	9-5-86	0.09	0.08
5-14-86	MS	A - B	5-20-86	9-9-86	ND	0.09
7-31-85	DD	H - L	8-20-85	9-9-86	350.92	482.85
7-31-85	DD	H - FO	8-20-85	9-5-86	7.45	9.50
9-9-85 (A)	DD	P - OC	9-18-85	9-5-85	0.16	0.24
9-9-85 (A)	DD	H - L	9-23-85	9-9-86	178.34	263.22
9-9-85 (B)	DD	P - OSN	9-18-85	9-8-86	261.82	363.96
9-9-85 (B)	DD	A	9-18-85	9-9-86	1.77	2.31
9-26-85 (A)	DD	P - ISN	10-23-85	9-5-86	0.01	0.08
9-26-85 (A)	DD	P - OS	10-23-85	9-4-86	0.26	1.57
10-16-85 (B)	DD	A	10-22-85	9-9-86	2.04	2.78
10-10-85	DD	P - OF	10-15-85	9-4-86	0.88	4.50
10-10-85	DD	P - OSN	10-15-85	9-8-86	8.12	5.85
10-10-85	DD	P - IT	10-15-85	9-4-86	1.58	9.52
10-16-85 (A)	DD	H - FO	11-5-85	9-5-86	9.06	10.14
10-16-85 (A)	DD	A - B	11-4-85	9-9-86	0.08	0.15
10-16-85 (A)	DD	P - OF	11-4-85	9-4-86	0.33	1.81
10-16-85 (B)	DD	P - OF	11-5-85	9-4-86	0.36	12.06
8-8-85 (A)	FR	T - PR	12-2-85	9-11-86	73.79	74.52

(Continued)

TABLE B-5 (Continued).

Date sample collected	Subject	Sample code	Date of analysis	Date of reanalysis	Original value (µg)	Reanalysis value (µg)
8-8-85 (B)	FR	T - PO	12-2-85	9-11-86	134.27	212.78
8-8-85 (A)	FR	H - R	8-26-85	9-9-86	248.25	152.04
8-12-85 (A)	FR	P - OC	8-27-85	9-5-86	0.33	0.30
8-12-85 (A)	FR	A	8-28-85	9-5-86	1.45	2.61
8-12-85 (A)	FR	H - R	8-28-85	9-9-86	323.62	179.76
8-13-85 (A)	FR	P - OB	8-27-85	9-4-86	1.13	7.26
8-13-85 (A)	FR	P - OS	9-5-85	9-5-86	7.23	8.21
8-13-85 (A)	FR	P - OT	9-5-85	9-9-86	14.39	13.51
8-13-85 (B)	FR	P - OSN	9-10-85	9-8-86	9.28	9.70
8-13-85 (B)	FR	A	9-10-85	9-9-86	4.46	5.60
8-13-85 (B)	FR	H - R	9-24-85	9-11-86	238.34	95.80
8-13-85 (C)	FR	P - B	9-10-85	9-4-86	ND	ND
8-13-85 (D)	FR	P - OT	9-11-85	9-4-86	1.36	8.02
8-13-85 (E)	FR	H - L	9-24-85	9-9-86	27.79	32.64
8-13-85 (E)	FR	T - PR	10-9-85	9-11-86	176.67	140.20
8-14-85 (A)	FR	P - OF	9-12-85	9-5-86	0.25	0.28
8-14-85 (A)	FR	H - B	9-12-85	9-9-86	ND	0.08
8-14-85 (C)	FR	P - B	9-16-85	9-5-86	ND	ND
8-14-85 (C)	FR	P - OSN	9-16-85	9-9-86	0.28	0.29
7-23-85	DP	P - OSN	7-31-85	9-8-86	5.10	1.20
			ETHAZOL			
4-28-86	VG	H - L	5-15-86	9-11-86	0.71	0.49
4-29-86	VG	P - IF	5-15-86	9-5-86	0.05	ND
5-27-86	VG	P - B	7-2-86	9-9-86	ND	ND
5-27-86	VG	H - FO	7-7-86	9-12-86	4.24	5.75
5-27-86	VG	P - FO	7-2-86	9-5-86	5.14	3.99
5-29-86	VG	P - FO	7-8-86	9-12-86	4.49	3.50
5-29-86	VG	H - FO	7-10-86	9-12-86	0.54	0.91
5-29-86	VG	H - R	7-10-86	9-12-86	0.44	0.53
3-5-86	KM	A - B	3-21-86	9-10-86	ND	0.07
3-12-86	KM	P - IT	4-9-86	9-9-86	0.13	0.10
3-12-86	KM	P - IC	4-9-86	9-9-86	0.01	ND
4-8-86	KM	H - L	4-14-86	9-11-86	0.10	0.21
5-20-86	KM	P - ISN	6-23-86	9-9-86	0.09	0.08
5-22-86	KM	P - B	6-30-86	9-5-86	0.14	0.07
5-22-86	KM	A - B	7-1-86	9-10-86	ND	0.09
5-22-86	KM	H - R	7-1-86	9-11-86	0.46	0.53
5-22-86	KM	T - PR	7-17-86	9-9-86	128.08	133.49
5-22-86	KM	T - PO	7-17-86	9-9-86	143.15	149.10
6-4-86	KM	P - OT	7-17-86	9-9-86	1.39	1.05

(Continued)

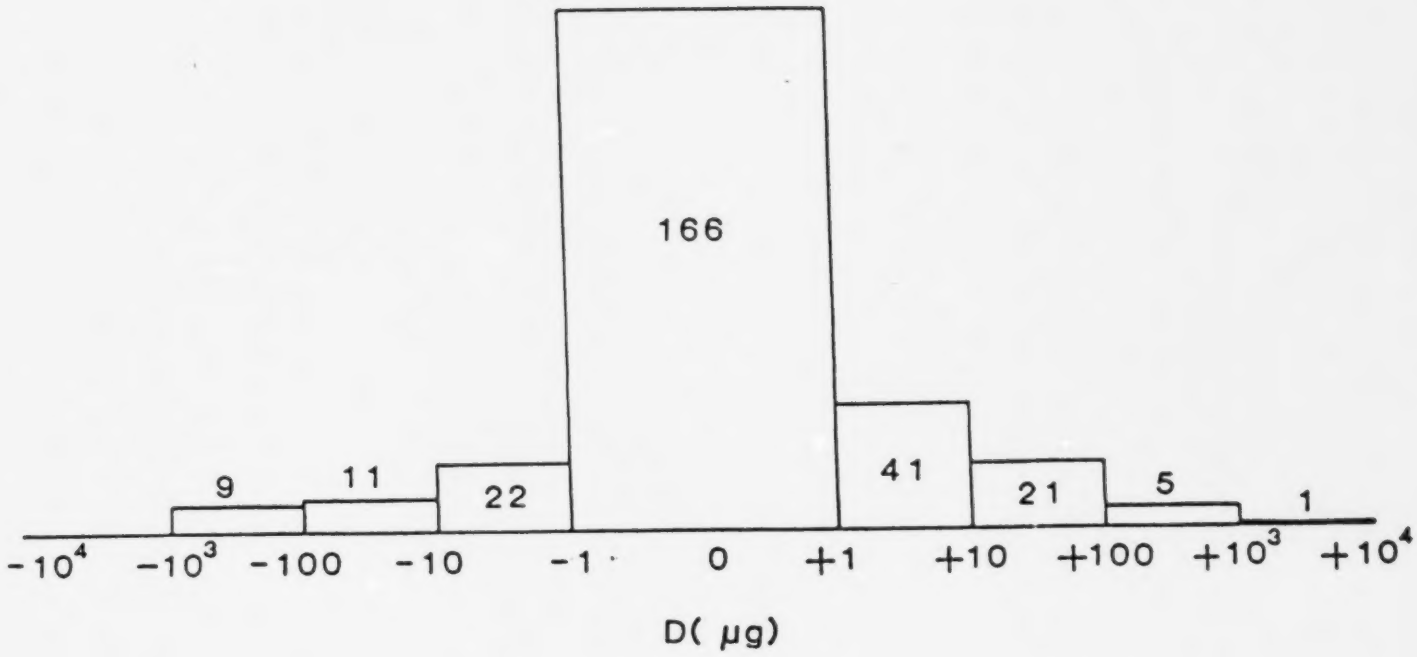
TABLE B-5 (Continued).

Date sample collected	Subject	Sample code	Date of analysis	Date of reanalysis	Original value (ug)	Reanalysis value (ug)
6-4-86	KM	H - B	7-18-86	9-10-86	ND	ND
4-7-86	MS	P - H	4-11-86	9-9-86	0.09	ND
4-7-86	MS	A - B	4-11-86	9-10-86	0.03	0.06
4-7-86	MS	H - R	4-11-86	9-11-86	0.17	0.24
4-15-86	MS	P - IC	4-25-86	9-9-86	0.08	0.08
4-21-86	MS	H - FO	5-13-86	9-12-86	2.22	1.88
4-21-86	MS	A	5-13-86	9-12-86	3.58	2.88
4-21-86	MS	H - B	5-13-86	9-10-86	0.02	0.14
5-1-86	MS	P - H	5-20-86	9-5-86	ND	ND
5-14-86	MS	P - OC	6-10-86	9-9-86	1.09	0.84
5-15-86	MS	P - IT	6-16-86	9-9-86	0.14	0.12
9-9-85 (B)	DD	P - OT	9-18-85	9-9-86	9.52	6.97
9-9-85 (A)	DD	H - R	9-25-85	9-11-86	4.98	3.18
			DICOFOL			
1-30-86	GG	P - IF	2-21-86	9-16-86	0.02	ND
1-30-86	GG	P - OB	2-21-86	9-16-86	0.04	ND
2-3-86	GG	P - FO	2-25-86	9-17-86	9.43	7.30
2-3-86	GG	H - FO	2-25-86	9-19-86	7.75	7.36
2-3-86	GG	A - FO	2-25-86	9-19-86	7.88	6.74
2-6-86	GG	P - H	2-28-86	9-16-86	ND	ND
2-6-86	GG	P - ISN	2-28-86	9-19-86	ND	ND
2-6-86	GG	P - OC	2-28-86	9-16-86	0.16	ND
3-10-86	GG	P - OSN	3-25-86	9-16-86	57.88	3.63
3-10-86	GG	H - B	3-25-86	9-17-86	ND	0.10
3-10-86	GG	A - B	3-25-86	9-19-86	0.07	0.05
3-13-86	GG	P - ISN	3-27-86	9-16-86	0.03	0.05
3-18-86	GG	P - IC	4-1-86	9-17-86	ND	0.03
3-18-86	GG	T - PR	4-1-86	9-19-86	114.48	160.43
4-7-86	GG	P - ISN	4-15-86	9-17-86	ND	0.06
4-10-86	GG	P - B	4-17-86	9-19-86	0.01	ND
4-10-86	GG	A - FO	4-21-86	9-16-86	14.16	7.40
4-10-86	GG	H - L	4-22-86	9-16-86	0.96	1.22
4-14-86	GG	P - H	5-7-86	9-16-86	ND	0.09
4-14-86	GG	A - B	5-7-86	9-16-86	0.05	0.12
			CAPTAN			
8-12-85 (B)	FR	P - OB	8-30-85	9-12-86	1.33	0.54
8-13-85 (A)	FR	A	9-9-85	9-12-86	1.67	0.73

(Continued)

TABLE B-5 (Continued).

Date sample collected	Subject	Sample code	Date of analysis	Date of reanalysis	Original value (ug)	Reanalysis value (ug)
8-13-85 (C)	FR	A	9-10-85	9-12-86	2.11	1.56
8-13-85 (D)	FR	P - OB	9-11-85	9-12-86	0.12	ND
8-14-85 (A)	FR	H - FO	9-23-85	9-12-86	1.52	0.54
8-14-85 (B)	FR	P - OF	9-16-85	9-12-86	0.08	0.10
8-14-85 (B)	FR	T - PR	10-9-85	9-12-86	559.83	385.50
			CHLOROTHALONIL			
8-22-85	DD	P - OT	9-16-85	9-15-86	91.42	62.65
8-22-85	DD	H - L	9-25-85	9-16-86	393.78	198.01
8-22-85	DD	P - OC	9-16-85	9-15-86	5.35	0.23
9-26-85 (A)	DD	H - L	10-23-85	9-16-86	421.16	340.77
9-26-85 (A)	DD	H - R	10-23-85	9-16-86	1088.80	724.60
9-26-85 (B)	DD	P - OT	10-1-85	9-15-86	326.30	170.74
9-26-85 (B)	DD	P - OSN	10-1-85	9-15-86	605.42	380.87
9-26-85 (B)	DD	H - R	10-1-85	9-16-86	567.60	368.66
8-7-85 (A)	FR	P - OB	8-23-85	9-15-86	1.60	1.08
8-8-85 (A)	FR	P - B	8-26-85	9-15-86	ND	ND
8-8-85 (A)	FR	H - L	8-26-85	9-16-86	87.92	92.43



APPENDIX B. Figure B-1. Frequency of D-values from a reanalysis of 276 samples. D(µg) = [reanalysis value (µg) minus original value (µg)]